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DOMESTIC CAPABILITY BUILDING AND INWARD TRANSFER IN THE CUBAN PETROLEUM INDUSTRY

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To put it crudely economic development is about enhancing capability and opportunity to learn at all levels. Technological learning is fundamentally important but so is the social and political learning that is necessary to build institutions and policy strategies that support competence-building (Lundvall, Vang, Joseph, & Chaminade, 2009, p. 19).

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ABSTRACT

Innovation and innovation system studies have traditionally not dealt with natural resource industries in developing countries. This seems to be the case even when considering strategic sectors such as the petroleum industry, where oil-rich countries are typically struggling to transform their hydrocarbons into sustained economic growth and development.

This thesis seeks to address the void in the literature. By combining the sectoral systems of innovation approach with bargaining power and value chain theory, the thesis sets out to explore the small-scale and onshore-based petroleum industry of Cuba.

A central argument throughout the thesis is that for Cuba to further develop its petroleum industry, it would be well-advised to formulate a policy aimed at facilitating the transfer of technology and knowledge held by foreign oil companies. In parallel it is acknowledged that such transfers are difficult to facilitate, depending among others on the bargaining power of Cuba to access the technology and knowledge, and on the ability of Cuban actors to assimilate and exploit the transfers.

Based on a collection of various documents, archival records, and interviews, it is found that the processes of inward transfers of technology and knowledge in the Cuban petroleum industry are limited to whatever agreements Cuba manages to strike with foreign oil companies directly investing in its sector. Through joint ventures and other agreements, however, domestic industry actors have managed to expand on their knowledge and technological base. This feat can be attributed to the ability of the Cuban educational system to supply the industry with manpower capable of absorbing the transfers.

On the background of this study it is argued that oil-rich developing countries should take a firm look into its petroleum technology policy, and outline goals and measures to facilitate the successful transfer of knowledge and technology from foreign oil companies operating on their soil. This would be crucial not just for the development of capabilities among domestic industry actors, but also to ensure that a proportionate share of the economic rent accrues to the country in question.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

Although the innovation literature endows us with few certainties, some assumptions seem to enjoy a near-general consensus. One is that innovation – or the development and diffusion of new technology – is crucial for long-term economic growth (Fagerberg, 2005; OECD, 2005; Rosenberg, 2004; Verspagen, 2005). Accordingly, innovation performance has been identified as one of the central factors explaining growth and growth-differences between countries (Fagerberg, 1987, 1994). A second central finding is that innovation activities rely heavily on external sources, which has led a number of scholars to apply system perspectives when examining innovation processes (Fagerberg, 2005). System perspectives on innovation have gained widespread popularity during the last couple of decades (Sharif, 2006), but fall short of providing anything close to a blueprint for the design and evaluation of growth-inciting policies (Fagerberg, 2005). In addition, the bulk of these studies have focused on industrialized nations, or alternatively on countries that have already succeeded in their catching-up efforts (Intarakumnerd, Chairatana, & Tangchitpiboon, 2002).

During the past few years, however, studies dealing with systems of innovation in developing countries have grown in number (Lundvall, Vang, Joseph, & Chaminade, 2009). Nevertheless, in large they do not address systems where natural resource industries are the focal point of study. This seems to be the case even when considering strategic industries such as the petroleum industry, where countries with abundant endowments have been struggling to transform their hydrocarbons into sustained economic growth and development (Humphreys, Sachs, & Stiglitz, 2007).[1]

This thesis seeks to address the void in the literature by applying the sectoral systems of innovation and complementary approaches on Cuba, a country possessing a small, onshore-based petroleum industry prone to significant growth if major offshore discoveries are made in the future.

1.1 BACKGROUND

The notion that petroleum-rich countries generally fail to reap the benefits of their favorable resource endowment has been coined the ‘oil curse’ (Humphreys et al., 2007). This inability

[1] System studies of countries that have succeeded in this transformation seem more abundant, however (See e.g. Dantas & Bell, 2009; Engen, 2009; Fagerberg, Mowery & Verspagen, 2009; Sasson & Blomgren, 2011; Silvestre & Dalcol, 2009).

has been especially prominent in developing countries, where the vast bulk of global oil and gas resources are located today. The oil curse is a complex phenomenon, where several different processes come into play. There are purely economic challenges, such as currency appreciation due to resource revenues and its negative effect on the competitive position of other industries, phrased as the 'Dutch Disease'. Second, oil and gas are subject to considerable price fluctuations that often have disruptive effects on domestic economies. Third, a political challenge lies in the fact that large petroleum revenues create incentives for rent-seeking behavior, as observed in many countries. Adding to this are challenges stemming from asymmetries in information and bargaining power between oil-rich developing countries and foreign oil companies (Soros, 2007). The outcome has often left the former with a disproportionally small share of the value stemming from petroleum activities at their own soil.

Nevertheless, notions of the inevitability of the oil curse have been challenged in recent years. Increasingly, a number of petroleum rich countries have been able to reduce the asymmetries, develop well-functioning domestic petroleum sectors, and capture a larger share of the value added. As will be discussed, this has been noted in countries as different as Norway and Angola over the last decades. Facilitating such processes is not a straightforward task, however. It involves the development of appropriate regulations and frameworks that optimize national value creation – by stimulating employment and entrepreneurship, value-addition, as well as the transfer and exploitation of technology and knowledge from abroad. In addition, it requires petroleum-rich countries to acquire a firm understanding of the petroleum industry value chain and its economics (Sigam & Garcia, 2012).

1.2 THE CASE

For Cuba, a country with a tradition of being dependent on external powers to subsidize most of its energy consumption, prospects of an offshore-based petroleum industry have been debated for some years. A U.S. Geological Survey report estimates that a mean 4.6 billion barrels of oil and 9.8 trillion cubic feet of natural gas lie undiscovered below the seabed of the deepwater area of Cuba's Exclusive Economic Zone in the Gulf of Mexico (U.S. Geological Survey, 2008). If certified as recoverable, it could make Cuba self-sufficient in energy and leave the island financially independent for the first time. Although much is uncertain and offshore reserves have yet to be discovered in commercially viable quantities, Cuba's petroleum sector will probably grow in significance in the future.

The quest for Cuba is to transform its hydrocarbon potential to long-term economic growth and development. As for other countries, this will pose significant challenges. Much will depend on whether Cuba is able to build on and further develop its petroleum sector capabilities, by facilitating transfers of technology and other knowledge-related assets from abroad, while supporting capability building in domestic organizations.

1.3 OBJECTIVE AND RESEARCH QUESTIONS

The objective of this thesis is to describe the characteristics of Cuba's petroleum industry, and to explore its opportunities to access and facilitate transfers of technology and knowledge from abroad. In doing so, I will apply the sectoral system of innovation framework and complementary approaches. As Cuba's petroleum sector is located far from the global technology frontier, a broad and context-specific interpretation of innovation is assumed: rather than to develop capabilities to create new to the world innovations, what is relevant for the development of Cuba's petroleum sector is to facilitate transfers of technology and knowledge from abroad and adapt these to local circumstances (González, 2012; OECD, 2012; Pietrobelli & Rabellotti, 2009).

It is further discussed that power relations, an often neglected theme in the systems of innovation literature (Lundvall, 2007), are critical when considering development opportunities in the petroleum sector. In the international petroleum industry, large and prevailing asymmetries in power, capital, and technological know-how between oil-rich countries and international oil companies have been identified as some of the main explanatory factors for the low share of value added accruing to the former (Soros, 2007). In relation, the relative bargaining power between the two sets of actors is identified as the key determinant of this distribution (Vivoda, 2009, 2011). It is argued here that the relative bargaining power of Cuba is crucial for the sector's *access* to foreign technology and knowledge, as well as for its share of economic rent stemming from petroleum production on Cuban soil.

In parallel, it is acknowledged that transfers of these types are difficult to facilitate. It depends on a variety of factors, including whether the Cuban government aims at facilitating such transfers in the first place. As noted in the oil curse literature, this is rarely the case in oil-rich countries, where purely rent-seeking behavior seem to be higher on the agenda of political elites (Humphreys et al., 2007; Kurtz & Brooks, 2011; Ross, 2003; Swilling, 2012). Further, transfers of these types are often tacit in nature (Verspagen, 2005), and involve actors

that often differ in goals and interests. What is more, the successful facilitation of such transfers demands a sufficient level of absorptive capacity on the part of the receiver (Cohen & Levinthal, 1990). In consequence, it is argued that the successful *facilitation* of such transfers heavily depends on the petroleum technology policy of the oil-rich country: whether it aims at and manages to facilitate inward transfers, while stimulating sufficient absorptive capacity in domestic actors.

Although difficult to achieve, if the oil-rich country manages to access and facilitate inward transfers this will result in increased capabilities among domestic petroleum sector actors. This would leave the host stat less dependent on the resources of foreign oil companies to conduct activities in its petroleum sector. It is argued here that this would increase the relative bargaining power of the host state in future bargaining processes, making it better positioned to grasp a larger share of the value added.

Based on the preceding sections, the research question of this thesis is:

What characterize the processes of domestic capability building and inward transfer of knowledge and technology in the Cuban petroleum industry?

In order to answer this, the following three sub-questions are posed:

What is the basis of Cuba's bargaining power versus foreign oil companies?

This question is formulated to explore Cuba's opportunities to access technology and knowledge held by foreign oil companies. The main finding shows that Cuba, based on a limited level of proved oil reserves and a high dependence on the participation of foreign oil companies to extract and produce the petroleum, possesses *a weak relative bargaining power versus foreign oil companies*. Factors related to a high risk assessment for business investments, and a high dependence on petroleum for electricity production provide additional support to this perception.

Nevertheless, additional Cuban petroleum reserves might be discovered in the future. What is more, as will be shown in the cases of Norway and Angola, a high dependence on foreign oil companies does not preclude substantial transfers of technology and knowledge from these companies to domestic actors.

The successful facilitation of such transfers depends on the petroleum technology of the host state, however. As such the second sub-question of this thesis is:

What are the main components of Cuba's petroleum technology policy*?*

The main findings is that *(i) Cuba has favored a high degree of openness to foreign participation in its petroleum sector since the beginning of the 1990s*; and *(ii) inward transfers and domestic capability building have been actively sought through joint ventures and product sharing agreements with foreign oil companies operating in Cuba's petroleum sector.*

This has allowed for significant transfers of technology and knowledge to domestic industry actors, resulting among others in the capabilities of Cupet – Cuba's national oil company – to extract and produce petroleum without foreign assistance. This is significant in that is has allowed for a greater share of economic rent accruing to Cuba than what would have otherwise been the case.

Despite the policy measures, Cuba's access to foreign technology and knowledge seem limited to whatever agreements the country is able to strike with foreign oil companies operating in its sector. As a whole, the island state does not belong to the international petroleum industry knowledge network due to its lack of attractive projects, finance, and managerial expertise.

The third sub-research question of this thesis is posed to give a contextual account of Cuba's petroleum industry, and to further explore the processes of domestic capability building and inward transfers in the sector:

What is the division of tasks between Cuban and foreign actors along Cuba's petroleum sector value chain?

As all subsoil petroleum resources are the property of the state, they are under the ultimate control of the Cuban government. In this sense *(i) the whole petroleum value chain is controlled by the state or state-controlled enterprises*. There is no room for private domestic actors. Most significantly, Cupet has operations along all stages of the value chain.

On the other hand, *(ii) there is a small number of joint ventures with foreign oil companies along the chain*. The ventures can be categorized into two broad types. In the 'market oriented' ventures, Cuba is trading a significant share of the economic rent in return for increased production of oil and gas, as well as for inward transfer of technology and knowledge to domestic actors. The 'strategically oriented' type on the other hand, stems from Cuba's close relationship with Venezuela. The aim here is to increase domestic capabilities a variety of downstream activities, in particular in crude oil refining.

Based on the findings from the three sub-research questions, the main research question is answered:

> ***What characterize the processes of domestic capability building and inward transfer of knowledge and technology in the Cuban petroleum industry?***

Through its petroleum technology policy, Cuba has sought to access foreign technology and knowledge to build domestic petroleum sector capabilities. The scale of the transfers is, however limited by Cuba's petroleum resources, and its lack of access to the international petroleum industry knowledge network. As such *(i) The processes of inward transfer of technology and knowledge in the Cuban petroleum industry are limited to whatever agreements Cuba manages to strike with foreign oil companies investing in its sector.*

Through its contractual framework, Cuba has nevertheless managed to link up with a small number of foreign oil companies investing in its sector. *(ii) Through these agreements, domestic actors in Cuba's petroleum sector, most notably Cupet, have managed to expand on their knowledge and technological base, and increased their capabilities.*

The learning conducted through these linkages can be accredited to *(iii) the ability of the Cuban educational system to supply the industry with manpower capable of absorbing the inward transfers*.

1.4 MAIN CONTRIBUTIONS

The contributions from this thesis are manifold. First, this thesis shows that the combination of different theoretical frameworks works as to study domestic capability building and inward transfers in a developing country context.

Second, it offers an extension to the sectoral system of innovation literature by focusing on processes of domestic capability building and inward transfer of knowledge and technology in a petroleum sector. In doing so, it draws on the bargaining power literature, arguing that a country's access to these assets is mediated by its relative bargaining power versus the foreign oil companies in possession of them. In parallel, the thesis also suggest a revision of the bargaining power literature, arguing that processes of inward transfer of technology and knowledge have been neglected as a source of bargaining power for host states.

Third, a new model is formulated in this thesis. The model concerns the circular causality between host state relative bargaining power and host state capabilities. It is

suggested that this model, linking the system of innovation approach with bargaining power theory, is applicable to other cases than the one under study in this thesis.

1.5 OVERWIEW OF THE THESIS

The thesis consists of five different chapters. The current introductory chapter contains the thesis rationale, its objective and research questions, as well as its main contributions. Chapter two covers the theoretical framework and concepts to be applied in the analysis. Chapter three encompasses the relevant domestic and international context of Cuba's petroleum sector, as well as a brief presentation of the successful development of the petroleum sectors of Norway and Angola. Chapter four describes the methodology of this thesis, presenting the research design, procedures of data collection and analysis, as well as considerations of validity, reliability, and ethics. Chapter five presents the empirical findings, and is structured to answer each of the research questions in turn. Chapter six concludes the thesis with a summary of the main findings, before implications and suggestions for further research are offered.

2. THEORETICAL FRAMEWORK

This chapter presents the theoretical framework of the thesis. It starts out by discussing the system of innovation literature, stressing the conceptual similarities of the different approaches. Based on this, an account of the sectoral systems of innovation approach is presented. Then some considerations that have to be taken into account when studying innovation systems in developing countries are given. The two concepts of inward transfer and absorptive capacity are discussed in this context.

Subsequently, a presentation of the value chain approach is offered, stressing its compatibility with the systems of innovation framework. This section continues with an account of the petroleum sector value chain. Next, the bargaining power approach is presented, emphasizing its relevance for host states' access to technology and knowledge from abroad. Further, an account of petroleum technology policy is presented. The chapter ends with a proposed model concerning the circular causality of host state relative bargaining power and host state capabilities.

2.1 SYSTEMS OF INNOVATION

In the following sections I present and discuss the main propositions from the systems of innovation literature; its controversies, strengths and weaknesses, - as well as its application in this thesis. I will mainly focus on the sectoral system of innovation and production approach as developed by Franco Malerba, although contributions from other systemic approaches will be taken into account when they contribute to elaborations and clarifications. In this regard, it is important to note that the various approaches share many features, while maintaining that they are distinguished along other dimensions, such as in their technological, industrial, and spatial characteristics (Edquist, 2005; Fagerberg, 2005).

2.1.1 Sectoral Systems of Innovation

As stated in the introduction, innovation activities depend heavily on external sources. Firms and other innovation agents do not innovate in isolation, but in collaboration and interdependence with other organizations (Edquist, 2005). This has inspired a broad and heterogeneous literature, building on early contributions from authors such as Christopher Freeman (1987), Bengt-Åke Lundvall (1992), and Richard R. Nelson (1993), some of which use sectoral characteristics to distinguish between different systems (Fagerberg, 2005). It has been argued that the systems of innovation concept has its roots in the observation that

technological and social factors *interact* in the process of economic development, and that this might support a broad, more systemic approach to innovation (Fagerberg & Srholec, 2008).

The sectoral systems of innovation approach is applied here because it can be a useful tool in describing the development and characteristics of Cuba's petroleum industry. Malerba (2005a) offers the following definition of a sector:

> A sector is a set of activities that are unified by some linked product groups for a given or emerging demand which share some common knowledge (Malerba, 2005a, p. 385).

As for sectoral systems of innovation and production, Malerba (2002) states that:

> A sectoral system of innovation and production is a set of new and established products for specific uses and the set of agents carrying out market and non-market interactions for the creation, production and sale of those products. (Malerba, 2002, p. 250).

The *agents* in the system are organizations or individuals (e.g. scientists, entrepreneurs, and consumers). Organizations can be either firms or non-firm organizations, such as universities, financial institutions, government agencies, trade-unions and technical associations, or sub-units and groups of these. Agents interact through communication, exchange, co-operation, competition, supply and demand. Interactions among agents are shaped by *institutions*, like rules and regulations. Further, agents are heterogeneous, and differ in their learning processes, capabilities, beliefs, objectives, organizational structures, and behaviors.

As a whole the sectoral system is not static, but transforms over time through co-evolution of its different components (Malerba, 2002). A sectoral system has a knowledge base upon which innovation and production activities are conducted. The knowledge base differs across sectors, making innovative activities, organization and the behavior of agents unique for each sector. In addition to the knowledge base, sectoral systems contain technologies, inputs, and demand levels that may be both static and dynamic. A sector is further interconnected with other sectors, either vertically or horizontally (Malerba, 2002).

A sectoral system contains of different building blocks, the first of which is *knowledge base and learning processes.* Knowledge is central to the learning and innovation activities of agents. It varies in its properties of *accessibility* (e.g. opportunities of gaining knowledge external to the agent) and *cumulativeness* (e.g. to what degree the generation of new knowledge builds upon knowledge currently held by agents). If knowledge is easily accessible, the level of industry concentration goes down, and vice versa.

The ease of an agent's knowledge appropriability is mediated by its external environment. This can provide the agent with human capital or scientific and technological

knowledge produced in other organizations, like universities, research institutes, or suppliers (Malerba, 2002).

Further, cumulativeness means that innovation agents that currently possess knowledge will be more capable of acquiring *new* knowledge (Malerba, 2002, 2005a). In relation, cumulativeness is expected to lead to a selection process that favors established firms, or technological leaders.

In short, when knowledge is hard to access and characterized by a high degree of cumulativeness, the sector will tend to consist of a few large technological leaders. This is a resemblance of the Schumpeter Mark II model, and is typical for mature industries. Such industries are recognized by a pattern of *creative accumulation*, where innovations are introduced by firms that have innovated before. Here, technological change typically follows established trajectories, and economies of scale, entry barriers, and financial resources are important factors in the competitive process. According to Breschi, Malerba, & Orsenigo (2000) the oil and gas industry belongs to this category. Conversely, if the knowledge is easily accessible and low in cumulativeness, the resulting sectoral structure will tend to resemble a Schumpeter Mark I, where innovations are introduced by new, often smaller firms in a pattern of *creative destruction* (Malerba, 2002).

Secondly, sectoral systems differ in *basic technologies, inputs, and demand*. The products of a sector are often linked with a variety of technologies. Since the products of a sector differ from those of other sectors, the resulting technology-product matrix is unique for each sector. Further, basic technologies and demand shape the behavior and organization of innovation agents in a system:

> A given technological environment or demand defines the nature of the problems firms have to solve in their innovative and production activities and the types of incentives and constraints to particular behavior and organizations. (Malerba, 2002, p. 154).

The third building block of sectoral systems is the *types and structure of interactions among heterogeneous firms and non-firm organizations.* Firms are commonly noted to be the key agents in innovation systems (Edquist, 2005; Malerba, 2002). They are involved in the innovation, production and sale of products, and in the generation, adoption and use of new technologies. Firms can also be users or suppliers in production and innovation processes. They are heterogeneous in terms of types, beliefs, capabilities, behavior, interests, and organizational structure. The heterogeneity stems from differences in their knowledge base, experience and learning processes, interactions, histories, and rates and trajectories of innovation and growth.

Firms interact in various ways with other firms and non-firm organizations, such as different political entities, banks, universities and others. These organizations can contribute to the creation and diffusion of innovation and technology, but their roles differ across sectoral systems. In summary, "a sectoral system is composed by webs of relationships among heterogeneous agents with different beliefs, competencies and behavior […] these relationships affect agent's actions. They are rather stable over time." (Malerba, 2002, p. 256).

Institutions comprise the fourth building block. Institutions can be more or less formal, and include laws, rules, standards, routines, norms, established practices, or common habits. Institutions shape the cognition, behavior, and interactions among agents. Sectoral systems are often affected by national institutions, such as the juridical framework of the nation. National institutions often favor specific sectors, and may constrain the development of other sectors. On the other hand, sectoral variables can also influence and change national institutions, especially if the sector is of high strategic importance for the economy as a whole (Malerba, 2002).

Finally, *processes of selection and variety creation* form the fifth building block in sectoral systems of innovation. Related to the heterogeneity of agents in a system, these evolutionary processes greatly contribute to differences across sectoral systems (Malerba, 2005b). First, processes of *variety creation* refer to products, technologies, organizations, institutions, strategies, and behaviors. The creation of e.g. new non-firm organizations, such as technical institutes increase variety and can lead to new firm-entrants, technologies, or knowledge.

Variety creation greatly contributes to the dynamics of sectoral systems. In contrast, processes of *selection* reduce heterogeneity, either through market selection (e.g. changes in demand) or non-market selection, such as through processes of public procurement (Malerba, 2002).

2.1.2 Innovation Systems in Developing Countries

Given that the case under study in this thesis is the petroleum sector of Cuba, some points on innovation and innovation systems in developing countries deserve mention. In recent years efforts have been made to adapt and apply the systems of innovation framework on countries, regions, or sectors in the developing parts of the world.[2] This has not been uncontroversial, however, and the attempts have been criticized on several accounts. Pietrobelli & Raboletti

[2] See Lundvall, Vang et al. (2009) for a comprehensive account of SIs and developing countries (Lundvall, Joseph, Chaminade, & Vang, 2009).

(2009) list several reasons for why the application of innovation system frameworks in developing countries have been problematic: (*i*) because the processes of innovation are different in nature in developing countries as incremental innovation and absorption are more important than the creation of radical and new to the world innovations; (*ii*) because the nature of technological needs and market failures that surround technological efforts are of a different nature; and (*iii*) because science & technology organizations are often missing in developing countries, making linkages between non-firm organizations and firms weak or non-existent (Pietrobelli & Rabellotti, 2009).

In relation, one strand of criticism states that full-blown systems of innovation rarely exist in most developing countries. Thus, it has been argued, the task is not to study the structure and functions of such systems. Rather, the emphasis should be on developing strategies to *create* full-blown systems (Arocena & Sutz, 2000). Another, related criticism states that the system of innovation approach is solely applicable to developed nations. Only here are firms capable of introducing new to the world innovations. Following this strand, one should discard the notion of systems of innovation in developing countries and replace it with a more moderate concept, namely learning systems (Viotti, 2002).

Nevertheless, these views seem to be based on narrow understandings of innovation and innovation systems, where the focus is more on R&D-based innovation (or Science-Technology-Innovation (STI) mode of innovation). Learning conducted as employees encounter problems and challenges on the job, or in interactions with external customers (so-called Doing, Using, and Interacting (DUI) mode of innovation) on the other hand, are often neglected (Brundenius, Lundvall, & Sutz, 2009) – but by no means less important (Lundvall, Vang, et al., 2009).

As argued by Freeman (1995), economic growth is more dependent on effective diffusion of knowledge and technology than on being the first to create radical innovations, and as much on social innovations as on strict technological innovations.[3] Lundvall et al. (2009) elaborates on these points: "Having a long tail of slow adopters and a few world-leading firms may be less attractive than having many firms that are quick adopters without any world leaders." ." (Lundvall, Vang, et al., 2009, pp. 9–10). When considering innovation in developing countries it is thus more appropriate to understand it as not only new to the world technologies " but also improvements in areas such as logistics, distribution and marketing [that are] new to the local context, even if the contribution to the global knowledge

[3] These issues are also discussed in Von Tunzelmann & Acha (2005).

frontier is negligible." (Fagerberg, Srholec, & Verspagen, 2010, p. 2). With such an understanding, it is valid to discuss innovation processes and their corresponding systems in developing countries (Fagerberg & Srholec, 2009).

2.1.3 Inward Transfer and Absorptive Capacity

As discussed, small and developing countries typically find themselves far from the global technology frontier in most sectors. According to the National Science Board (2010), the G7 countries alone accounts for about 65 percent of global R&D spending, whereas the countries included in the OECD accounts for some 80 percent (National Science Board, 2010, pp. 4–34).[4]

However, the real economic benefits of innovation stem from its effective translation into economic gains, not from its creation. In consequence, what is most relevant for sectoral systems in countries like Cuba is often to facilitate the successful transfer of knowledge and technology from abroad and to adapt these to local circumstances (González, 2012; OECD, 2012; Pietrobelli & Rabellotti, 2009). This seems to be the case also when considering Cuba's petroleum industry, as this type of industry - despite being based on natural resources – is becoming increasingly technology intensive (Petrad, 2012).

In the literature on technology transfer there is, however, no consensus as to how easily such transfers move between agents and across borders. Most fundamentally there are different interpretations concerning whether technological knowledge is public or private in nature. Neoclassical theories of endogenous technological change have long noted that technology is non-rival and public in nature, thus creating spillovers to other agents (Grossman & Helpman, 1995; Romer, 1990). Hence, since innovation is costly and risky, a sound strategy for developing countries would be to simply acquire foreign technologies created in frontier countries and sectors.

On the other hand is the view – prominent in the innovation literature – that transfer of technology and knowledge is neither costless nor unconditional (Keller, 2004).[5] This is because important aspects of technology make it a private rather than public good. According to Verspagen (2005), the transfer of "[p]ure public goods do not require any special efforts or special skills on the side of the consumer or receiver of the services of the good. This is obviously not the case for technological knowledge." (Verspagen, 2005, p. 490). The reason

[4] Although associated with considerable constraints, R&D indicators are commonly used as a measurement for innovation (Smith, 2005).

[5] According to Fagerberg & Godinho (2005) the view that technology transfer and 'catch-up' is difficult to achieve is associated with the economic historian Alexander Gerschenkron.

is that technological knowledge often has a strongly tacit and cumulative character, making knowledge asymmetries hard to even out.

In relation, the empirical evidence of the benefits of *inward transfers* – meaning international flows of technology and knowledge through channels such as FDI (Mowery & Oxley, 1995) - is mixed (Görg & Greenaway, 2004; Keller, 2004). However, the lack of clear-cut evidence of its benefits might be explained by the lack of sufficient absorptive capacity (Fu, Pietrobelli, & Soete, 2011).

In this thesis it is therefore argued that the successful transfer of technology and knowledge relies on substantial and well-directed technological efforts (Lall, 2004) and on sufficient absorptive capacity on the part of the receiver (Cohen & Levinthal, 1990; Zahra & George, 2002), the latter referring to an ability to "recognize the value of new information, assimilate it, and apply it to commercial ends." (Cohen & Levinthal, 1990, p. 128).

2.1.4 Limitations of the Systems of Innovation Approach

On his account of systems of innovations Edquist (2005) considers some of the weaknesses of the approach. They are often related to the fact that the framework still lacks conceptual clarity, and that it does not qualify as a formal theory. This is because it does not provide "specific propositions regarding causal relations among variables." (Edquist, 2005, p. 186). Innovation system researchers disagree on the seriousness of these limitations (Edquist, 2005), as is further discussed in Sharif (2006) regarding national innovation systems.

A number of scholars have also stressed that the systems of innovation literature has underemphasized the international dimension (Asheim & Herstad, 2005; Pietrobelli & Rabellotti, 2009, 2011). They stress that international exchanges of information and technology have a great impact on the generation and diffusion of knowledge. In addition, as stressed in the introductory chapter of this thesis, the literature has traditionally left little focus on systems in developing countries. Further, the approach seldom addresses resource-based sectors. Finally, the approach has been criticized for neglecting power relations and its impact on development (Lundvall, 2007).

In this thesis I will seek to address some of these points by stressing the importance for Cuba's petroleum sector to establish and maintain channels of inward transfers from foreign actors, at different stages of the petroleum sector value chain. Further, power relations are taken into account with the emphasis on relative bargaining power between petroleum-rich countries and foreign oil companies, and how this determines the distribution of petroleum

rents, technology and other knowledge-related assets. Finally, the choice of case addresses the relative lack of system studies, both in natural resource-based industries and in developing countries.

2.2 THE PETROLEUM SECTOR VALUE CHAIN

2.2.1 Value Chains and Innovation Systems

Value chain analysis investigates the sequence of activities required to bring a product or service from conception or procurement, through the different phases of production and distribution, to the final customer and disposal after use (Kaplinsky & Morris, 2001, p. 4). The value chain approach is applied at different analytical levels, from individual firms to selected industries, within or across national borders. It was popularized by Porter (1985) who stresses that activities along the chain are not independent form each other, but interconnected by intra-chain linkages (Porter, 1985, p. 48). Value chains are often depicted in a simplistic matter. In reality, though, each link in the chain can consist of a range of different activities. Further, intra-chain linkages are often of a two-way nature, and significantly more complex than what is depicted in models (Kaplinsky & Morris, 2001, pp. 4–8).

Value chain analysis has been criticized for downplaying contextual factors that influence the function of the chain, such as the institutional framework (Pietrobelli & Rabellotti, 2009), environmental considerations (Bridge, 2008), and other factors that feature more prominently in the systems of innovation literature. Nevertheless, as was in fact noted by Malerba (2002), the value chain approach as developed by Porter (1985) shares several common characteristics with the (sectoral) systems of innovation framework. Recent studies have integrated the two approaches. They stress that effective flows of knowledge and collaboration for innovation among actors in the chain, are prerequisites for the chain to be competitive and meet consumer demand. Moreover, the role of a supporting environment is emphasized in this respect (Anandajayasekeram & Gebremedhin, 2009).

Innovation researchers also stress the compatibility of the two approaches. As stated by Lundvall & Borrás (2005): “The systems approach introduces a vertical perspective on the industrial system, seeing it as a network and as value chains where certain stages might be more suitable for firms in a specific country.” (Lundvall & Borrás, 2005, p. 612). Further, according to Lundvall et al. (2011): “The innovation system may be seen as constituted by ‘relationships’ between agents operating at different stages in the value chains.” .” (Lundvall, Gregersen, Johnson, & Lorenz, 2011, p. 7).

2.2.2 The Petroleum Sector Value Chain

In the petroleum industry the value chain encompasses the range of interlinked activities that jointly contribute to the transformation of petroleum resources into usable end-products (Figure 2.1). According to Tordo, Tracy, & Arfaa (2011), value creation (understood as social value at the industry level rather than private shareholder value) stems from three general sources. The first source is variables that are *exogenous to the actor's decision-making*, including the quality and quantity of the petroleum endowments, the geographic location of the country, as well as the structure of the domestic economy - including its dependence on and interactions with the petroleum sector. The second source is *the companies participating in the sector*, both private and public (national). Finally, *the sector's organization and institutional properties* is a source of value creation, and affect the ability and willingness of the companies to perform well (Tordo, Tracy, & Arfaa, 2011, p. 3).

The structure of the petroleum sector value chain is usually divided into *upstream, midstream, and downstream* activities. The different activities along the chain are conditioned by the *characteristics of the hydrocarbons*, of which the most important are oil and gas.

First, crude oil is a heterogeneous material, and is therefore classified along several dimensions. Of these, density and sulfur content are the two most important. Density is measured according to the guidelines set by the American Petroleum Institute (API). Here, (perhaps contra intuitively for some readers) light crudes generally exceeds 38∞ API, whereas heavy crudes have an API gravity of 22∞ or less. As for sulfur, crudes are usually described as sweet if the sulfur content is less than 1 percent. If it exceeds that level, it is sour (Tordo et al., 2011, p. 109). Crudes that are lighter (in terms of density) and sweeter (in terms of sulfur content) naturally produce a higher yield of lighter, more valuable products in the refining process further down the chain. In consequence, crudes that are light and sweet are valued higher than heavy and sour crudes. As will be explained in the analysis, Cuba's crude oil is heavy and sour, which have wide repercussions for activities along the value chain.

Gas on the other hand, can be found either in separate accumulations from oil (non-associated gas), or in combination with or in solution in crude oil (associated gas). Its composition varies widely, but often contains pure natural gas (methane); natural gas liquids (NGLs, such as ethane, butane, propane, iso-butane, and natural gasoline); and a number of impurities (such as carbon dioxide and water). Natural gas can either be classified as dry or wet, depending on its NGL content. Although efforts to find and process gas have stepped up

in recent years, it has historically not been considered as attractive as crude oil. This is because gas has to be moved by pipeline or by dedicated liquefied natural gas (LNG) vessels, which still make the development of markets for gas much more expensive than for oil (Tordo et al., 2011, p. 109).

Upstream activities include the exploration, development and production stages of the chain. It usually requires the highest amount of investments in the chain but also yield the highest potential profits (Sigam & Garcia, 2012). The exploration stage involves the identification of promising areas, geological analysis, and subsequent exploratory drilling if prospects are promising. If sufficient amounts of petroleum are found, additional appraisal wells are drilled to assess the commercial viability of the discovery (Tordo et al., 2011). The exploration stage can take from three to five years to complete. After the initial exploration the reserves are developed. Further, the development stage includes all activities and investments needed to prepare the site for commercial production, including evacuation routes. It can take from two to four years to complete, and the investments made here can amount to half of the total costs of a project (Sigam & Garcia, 2012). The next stage is petroleum production, which includes all activities connected to commercial extraction of the petroleum from the deposit. The cost of production varies considerably depending on the ease of extraction, field size, whether the field is on- or offshore, and the region of production. The amount of oil and gas production depends on the natural pressure of the reservoirs, and whether secondary and/or tertiary recovery methods are being used (Tordo et al., 2011). Production can last from 15 to 25 years and concludes the upstream section of the value chain.

Midstream activities cover transportation and storage, and link the supply and demand side of the value chain. Here, oil and natural gas are transported to appropriate processing facilities, and from those sites distributed or marketed. Crude oil is typically stored in holding tanks and transported by pipeline, truck, railroad, and/or tanker to processing refineries. Natural gas storage is carried out underground in depleted reservoirs, aquifers, or salt caverns. The type of transportation depends on the physical state of the gas: natural gas liquids (NGLs) are transported by pipeline or tanker trucks; dry gas only by pipeline, and even then not across the seabed of deep oceans (Tordo et al., 2011). Margins are usually lower in the midstream sector than in either upstream or downstream activities (Sigam & Garcia, 2012).

Further, *downstream* activities include oil refining and gas processing that turn the extracted petroleum into usable products. The value of the refined oil depends on the characteristics of the crude. As stated, crudes that are lighter and sweeter produce a higher yield of lighter, more valuable end products. Gas processing is usually conducted in dedicated

plants (fractionators) to become suitable for pipeline transportation (Tordo et al., 2011). When the refining or processing stage is completed, the hydrocarbons are marketed or distributed to end costumers, whether through wholesale, retail, or direct industrial clients.

Lastly, oil refining and gas processing products can also be distributed to the *petrochemical industry*. Here, the primary chemicals are turned into everyday products such as pipes, plastic packaging, electronic components, and tires. The plants are usually located next to refineries. Further, the industry is dependent on minimum plant dimensions to achieve economies of scale and be competitive (Sigam & Garcia, 2012).

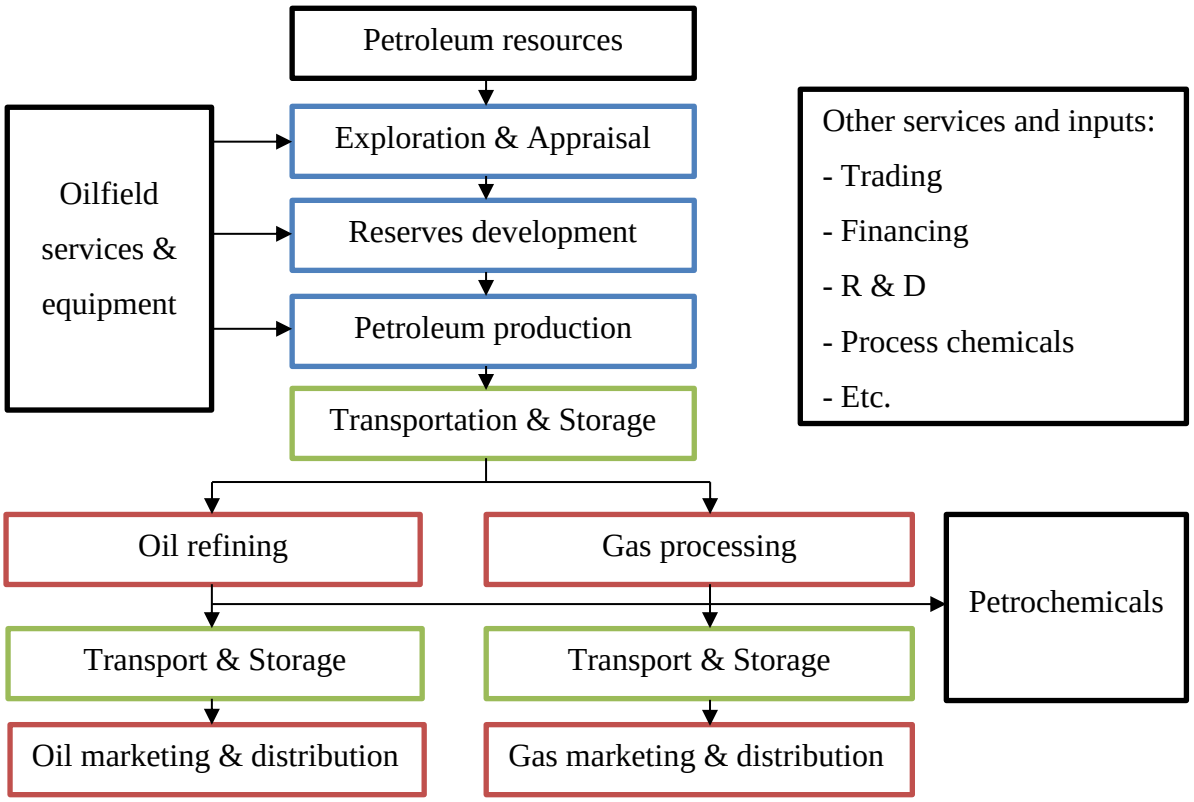


Figure 2.1: The petroleum value chain (Adapted from Tordo et al., 2011, p. 2). Upstream activities marked with blue border, midstream activities with green, downstream activities with red. Adjacent industries, other services, and petroleum resources marked with black.

2.3 BARGAINING POWER

The relative bargaining power among actors has been identified as a key determinant in the distribution of economic rent stemming from petroleum industry activities (Vivoda, 2009, 2011). It comes into play when petroleum-rich countries seek foreign assistance to contribute in the extraction and production of their hydrocarbon resources. Since petroleum industry activities in general - and upstream operations in particular - are highly capital and technology

intensive, petroleum-rich countries often depends on the participation of experienced and resource-rich foreign and multinational oil companies.

The model that is applied here was proposed by Vivoda (2011), who developed it based on an extensive review of previous literature on the subject. The framework focuses on *upstream* activities, which are spatially localized according to petroleum discoveries. The factors determining relative bargaining power among the actors – the host state and foreign oil company in question – are categorized into *basic entry conditions* and *international* and *host country* contextual factors respectively (Figure 2.2).

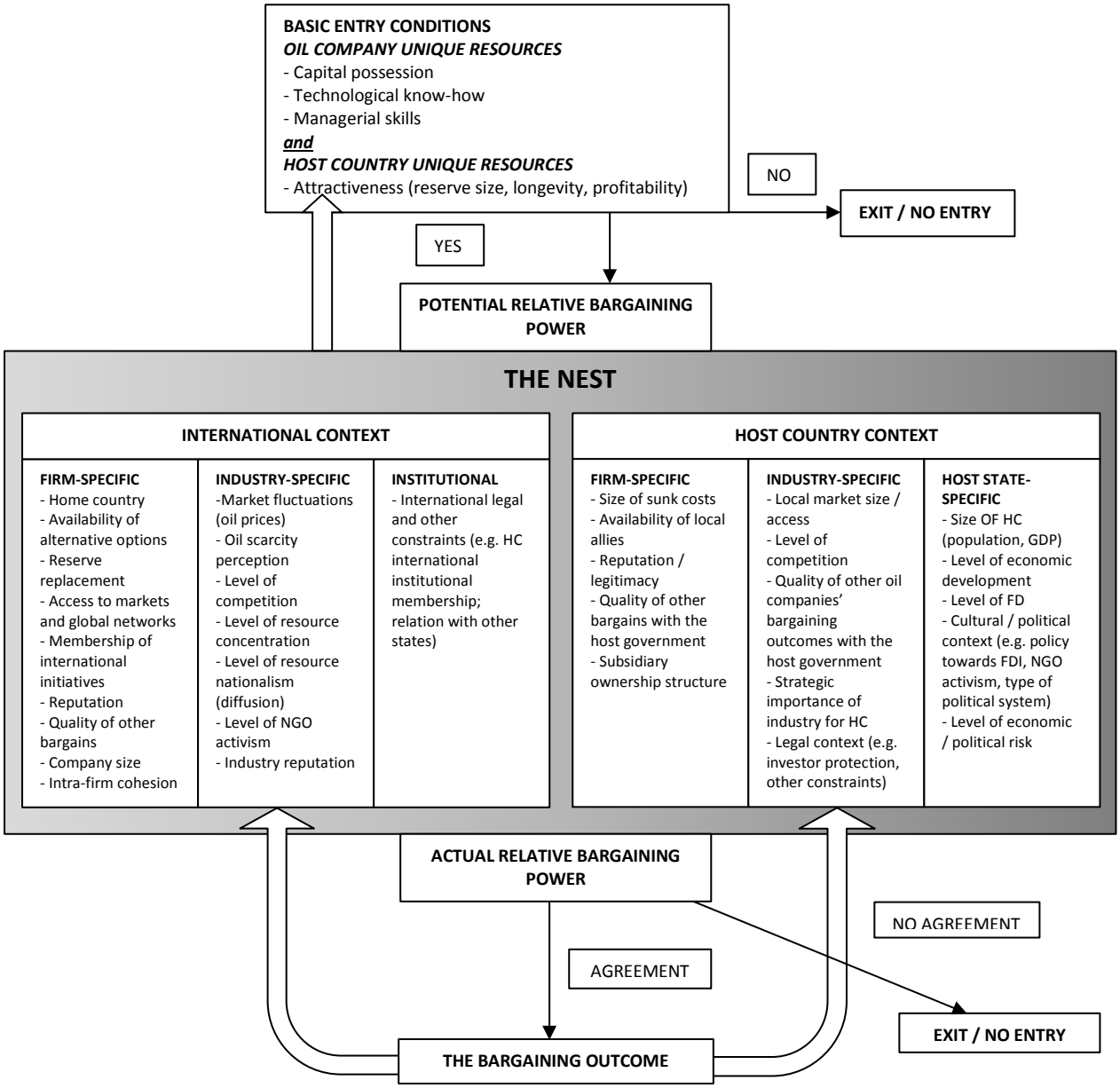


Figure 2.2: Oil industry dynamic bargaining model (Vivoda, 2011, p. 11).

Basic entry conditions are the set of unique resources that both the host state and foreign oil company need to possess in order to enter bargaining processes. For host countries these are the possession of petroleum resources, whose attractiveness are valued according to reserve size, longevity, and profitability. This point is in line with Dunning's (1981, 1988) view that multinational firms will invest abroad in order to access the immobile resources of a particular place. The foreign oil company on the other hand, needs to possess capital, technological know-how and managerial skills that are not easily copied by others. The relative possession of these assets shapes the *potential* relative bargaining power of the actors (Vivoda, 2011).

International and host country contextual factors mediate the potential and *actual* relative bargaining power between the actors. In the *international context* these are divided into *firm-specific*, *industry-specific*, and *institutional* factors. Here, firm-specific contextual factors are resources and constraints of the oil company in question, such as its home country, its access to and production in fields elsewhere, and its access to markets and global networks.

Industry-specific factors at the international level comprise among others the price of oil, industry competition, scarcity perception, and the level of resource concentration and nationalism in the in the international petroleum industry. If the industry-specific factors reach high levels, they are expected to increase the relative bargaining power of a host state, making it less dependent on foreign participation to increase domestic petroleum sector efficiency, and increasingly able to play the foreign oil companies against each other for block concessions.

In the model, institutional factors come into play when the host state is member of international organizations with sanction power. Such organizations might limit the actions of the host state on e.g. expropriation issues. On the other hand, membership of an international institution such as OPEC might increase the relative bargaining power of the host state (Vivoda, 2011).

In the *host country context*, factors are divided into *firm-specific*, *industry-specific*, and *host-state specific* factors. Here firm-specific factors relate among others to the size of the irretrievable costs that an oil company has already invested in the host state, its reputation in the host state, as well as its availability of local allies. If the oil company has already invested a large amount of sunk cost in the host state, its relative bargaining power is expected to decrease, whereas a good reputation and availability of allies is expected to increase its relative bargaining power.

Industry specific factors are conditions such as the domestic legal context of the petroleum sector, the size of the local market, and the strategic importance of the petroleum

industry for the host country. If the host country fails to provide sufficient investor protection, or if there is a history of legal battles between the host state and foreign firms, this is expected to decrease the relative bargaining power of the host state. Further, if the petroleum sector is of high strategic importance, or if the host state contains large and growing markets, the host state is expected to increase its relative bargaining power.

Finally, host state-specific factors comprise non-industry factors. These include the size of the host state, its level of economic development, its dependence on FDI, the political and cultural context (such as type of political system and policies toward foreign actors), as well as the economic and political risks of investing in the host state (Vivoda, 2011).

If a host state is highly developed, it is expected to enjoy a high level of absorptive capacity, thus being able utilize new information, and transform it to commercial ends. This is expected to increase the relative bargaining power of the host state. This also applies if the host state is large; it is then more likely to have power at its disposal in bargaining processes. Further, if the host state largely depends on FDI in its economy, this is expected to decrease its relative bargaining power. Finally, the political and cultural factors can mediate bargaining power. Sudden changes in attitude towards foreign participation can evaporate the relative bargaining power of these firms, whereas centralized authoritarian governments are less expected to be vulnerable to the influence of domestic societal groups (Vivoda, 2011). Whether this last point reduces or increases the relative bargaining power of the host state is not elaborated on in the model, although one could theorize that this depends on the attitudes of the domestic societal groups towards foreign participation in the first place.

The actual relative bargaining power between the host state and foreign oil company shapes the *bargaining outcome* if an agreement is reached. The outcome will also affect future bargaining processes, thus emphasizing the dynamic nature of the model (Figure 2.2).

A few clarifications about the application of the bargaining power model in this thesis have to be made. The bargaining power model proposed by Vivoda (2011) aims at being applied in analyses where specific bargaining processes between host states and foreign oil companies are the focal point of study. As such the model aims at offering a balanced framework of such processes, where no particular host state or oil company perspective is given predominance. Such a detailed analysis of one or more of Cuba's bargaining processes could undoubtedly lead to interesting propositions, but is outside the scope of this thesis.

The goal here is not to offer a detailed analysis of different bargaining processes that Cuba has conducted with foreign oil companies. Rather, the framework is applied in order to assess the basis of Cuba's bargaining power. This is done in order to explore the general

leverage Cuba possesses to access foreign technology and other knowledge related assets through foreign oil companies interested in investing in its petroleum sector. In consequence, industry-specific factors both on the international and host country context, as well as host country (non-industry) specific factors are especially emphasized, whereas firm-specific factors are downplayed.

2.4 TECHNOLOGY POLICY

As is hopefully clear from the sections on systems of innovation, the activities of innovation agents are strongly affected by external factors. Further, activities and performances of various actors in sectors co-evolve with institutions and policies at the national level. Hence, a country's technology policy is crucial for the innovative performance of a sector, and for its capabilities to access and absorb foreign technology.

Technology policy generally means different things for small and developing countries than it does for large and industrialized ones. Instead of building capabilities to produce and apply new (science-based) technologies, the focus is more often on outlining policies that facilitates the successful transfer of technology and knowledge from abroad. This is often sought done in targeted and established industries (Chaminade, Lundvall, Vang, & Joseph, 2009; Lundvall & Borrás, 2005).

In consequence, it is argued that the goal of Cuba's petroleum technology policy should be to facilitate linkages between firms and non-firm organizations domestically, as well as between domestic firms and foreign companies. Figure 2.3 illustrates the difference between mature and emerging innovation systems, and depicts the relative lack of linkages between agents in emerging systems. In emerging systems, the role of universities is typically limited to supplying manpower. DUI forms of learning are inhibited because of low user competence, and because the relationships among agents are lacking in trust. Similarly, STI forms of learning are often weak, due to low levels of research capabilities in universities and research entities (Chaminade et al., 2009).

On the other hand, emerging systems of innovation might evolve into mature systems, as firms and other building blocks accumulate the capabilities needed to engage in different forms of learning (Chaminade et al., 2009). In mature systems, linkages are more extensive. This signifies extensive transfers of technology and knowledge between different firms and non-firm agents along the value chain, which contributes to learning, capability building, and innovations.

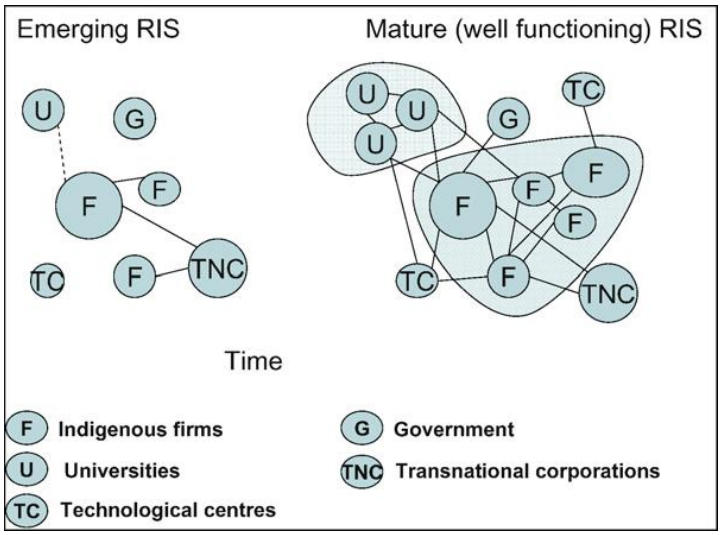


Figure 2.3: Linkage differences between emerging and mature innovation systems (Chaminade & Vang, 2008).

As stated, fostering linkages demands substantial and well-directed policy efforts, especially when the linkages cross borders. Nevertheless, accessing the knowledge and technology of foreign oil companies and other organizations can be a source of significant value creation, not least for petroleum sectors in developing countries.

In the petroleum industry, two main policy choices are relevant in this regard. The first and most basic one regards the level of desired foreign participation in the petroleum industry. This level may be varied along a continuum (Figure 2.4).[6] Countries often adopt different policies for the different stages of the petroleum sector value chain, but in reality no country in the world today resides on either of the extreme ends (Tordo et al., 2011). The degree of openness of a sector is usually formalized in laws and resolutions on the national level, such as the law of foreign investment of a country.

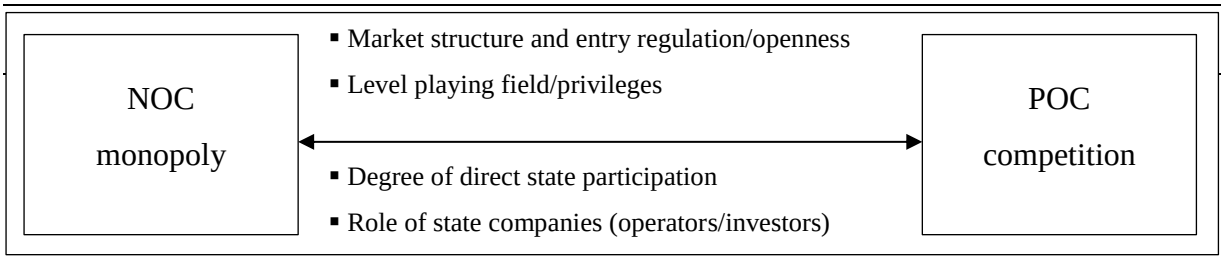


Figure 2.4: Options for levels of competition and participation in the petroleum sector (Tordo et al., 2011, p. 4).

The second policy choice is conditioned by the first, and concerns the specific agreements between host states and foreign oil companies. Host states might adopt a variety of contractual

[6] In every country in the world (apart from the U.S), the sub-soil is either state-owned, or the state retains a veto on its use, making the national government in charge of entry regulations for foreign and domestic firms (Mommer, 2002).

forms, such as risk service contracts (where all of the production belongs to the state) or product sharing agreements (where production is shared between the host government and the foreign company, see Appendix 1). Block concessions are usually auctioned or awarded to interested companies through bidding rounds.

Depending on the competition, bidding takes the form of commitments to the host country, and can be in the form of infrastructure development, training and capability building, technology transfer, the use of local contractors, or a minimum amount of spending on exploration (Tordo et al., 2011, p. 5). Included in the agreement between host states and foreign firms is also the level of taxation, such as on salaries and net profits. In upstream oil and gas, the total government take (or share of available cash flow from a petroleum project, see Appendix 1) varies around the world from around 40 percent to well over 90 percent (Johnston, 2007) (See Appendix 5).

After the bidding has been concluded, the contractual arrangements between the host country and foreign oil company are subject to further bargaining, where factors such as the quality of the oil, perceived risk, and transportation costs come into play.

2.5 BARGAINING POWER, CAPABILITY, AND POLICY

As stated in section 2.3, bargaining power is thought to determine the distribution of added value between host states and foreign oil companies. Among bargaining power researchers, value addition is usually understood as *economic rent* stemming from petroleum related activities (Vivoda, 2009, 2011). The concept of economic rent was widely discussed by classical economist, with David Ricardo being the first to develop a complete theory of the concept. In straight terms, economic rent equals extra incomes above the average profit rate in an economy, which stems from the ownership or control of especially fruitful land, such as oil-rich territories (Ryggvik, 2010, p. 20). In consequence, the bargaining between the actors is the process where the distribution of this particular type of rent is decided.

However, it is argued here that there is a *by-product* of bargaining processes that has received little attention in the bargaining power literature. The by-product stems from the fact that when agreement is reached, large amounts of foreign capital, technology, and managerial skills are transferred into the host country in question. Whether and to what degree this benefits the host state (beyond the share of economic rent resulting from the extraction of petroleum) depends on several factors, of which three are emphasized here: (*i*) the relative bargaining power of the host state; (*ii*) whether the petroleum policy of the host state includes

demands of technology and other knowledge-related assets to be transferred from the foreign oil company to domestic actors as part of the bargain and; (*iii*) the ability of the host state to assimilate and exploit the transfers.

If the host state succeeds in facilitating and absorbing the transfers, however, domestic actors will more able to conduct different petroleum sector activities. This *increase in domestic capabilities* will also increase the relative bargaining power of the host state in future bargaining processes. This will happen because the host state is now relatively more capable of conducting petroleum activities without foreign assistance (Figure 2.5). To put it differently, the host state has managed to reduce asymmetries in areas such technology and industry know-how relative to foreign oil companies.

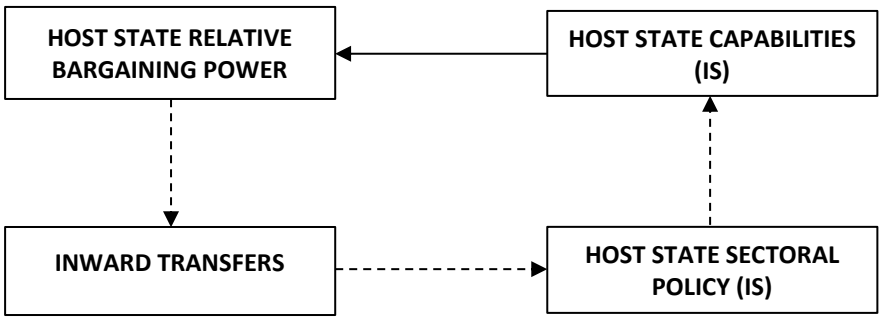


Figure 2.5: The circular causality of host state relative bargaining power and capabilities. (IS) = innovation system.

In consequence, efforts to facilitate such transfers should figure high on the technology policy agenda of host states. Further, as firms and other innovation agents are heavily influenced by systemic factors in their activities, the development of a well-functioning system that is capable of nurturing the absorptive capacity of domestic agents should be highly prioritized.

Note also that if the capabilities of domestic actors increase, this will not only improve the chances of the host state to capture a larger share of the economic rent in, but also its chances of accessing and facilitating the knowledge and technology of foreign oil companies. The resulting increase in inward transfers of technology and knowledge will again reduce asymmetries, making the host state even less dependent on foreign participation, and in an even stronger relative bargaining position than before. The processes signify a circular causality of host state relative bargaining power and capabilities (Figure 2.5).

Although the empirical material collected in this thesis cannot offer any valid conclusions of whether such processes have manifested themselves in Cuba's petroleum sector, it is worth noting that the successful facilitation inward transfers and domestic

petroleum sector capabilities have been identified by several authors as key factors for Norway's success in developing through its petroleum resources (Engen, 2009; Fagerberg, 2009; Ryggvik, 2010, pp. 90–114; Sæther, Isaksen, & Karlsen, 2011).

2.6 CONCLUSIVE REMARKS

In this chapter I have presented the different theories and models to be applied in the analysis of the processes of domestic capability building and inward transfers in Cuba's petroleum industry. It was argued that since Cuba's petroleum sector is located far from the global technology frontier, a broad and context-specific understanding of innovation is assumed. Further, what is most relevant for the development of Cuba's petroleum sector is to facilitate inward transfers of technology and knowledge from abroad, and to adapt these to local circumstances.

It was further argued that the access to foreign technology and knowledge in the petroleum industry – especially in relation to upstream operations where most of the economic rents are distributed – are mediated by the relative bargaining power of the host state. Such transfers are, power considerations aside, difficult to facilitate and heavily dependent on the petroleum technology policy of the host state: whether it aims at facilitating such transfers, and whether it nurtures absorptive capacity in its domestic petroleum sector actors. In this respect, it was theorized that the successful facilitation of such transfers, as indicated by increased domestic petroleum sector capabilities, will increase the relative bargaining power of the host state in future bargaining processes, and should thus be high on the agenda of the petroleum policy of host states. For host states this is decisive both to secure a larger share of the economic rent in future bargaining processes, and also for future inward transfers.

3. CONTEXT

This chapter provides an overview of the relevant context of the petroleum sector of Cuba. First, Cuba's economic situation is presented. This section will focus on the period since the abrupt ending of Cuba's longstanding economic and political orientation towards the East Bloc in the early 1990s. Second, an account of the international petroleum industry is outlined. Here I will concentrate on the historical shifts in relative bargaining power between international oil companies and petroleum-rich countries in the developing world. The last two sections of the chapter discusses the development of the petroleum sectors of Norway and Angola, two countries that differ in many respects, but have both succeeded in accessing technology and knowledge from abroad, and utilized it to build significant domestic petroleum sector capabilities.

3.1 CUBA IN TRANSITION

3.1.1 Backdrop

Ever since the revolutionary seizure of power by communist rebel forces in 1959, Cuba has survived more than 50 years of U.S. sanctions intended to topple the government of Fidel, and in later years, Raúl Castro. It has also defied predictions that it would not survive the collapse of its one-time supporter, the Soviet Union. Through the *Partido Communista de Cuba* and affiliated mass organizations, government bureaucracy and state security apparatus, the top national leadership has exercised control over virtually all aspects of Cuban economic and political life. The tight restriction on *political* rights such as freedom of speech and organization has, however, made *social* rights decisive in legitimizing the regime (Plahte, 2010, p. 156). In accordance, the regime has made efforts to provide its citizens with universal and free access to health care and other services. These benefits, along with a considerable public commitment to education, science, and technology have also been linked with the wider social and economic development of the nation (Jover, Arriete, Ones, González, & Cuavas, 2011; Sáenz, 2008).

However, Cuba's revolution has for long periods of time been bankrolled by some external power. Up until the collapse of the East Bloc, the country benefited from access to large and stable markets, along with capital, cheap loans, and technology - the latter often far from cutting-edge but nevertheless important for productivity growth in various sectors. Apart from this, Cuba secured its energy supplies through a highly advantageous trade agreement, by which Cuban sugar was exchanged for large quantities of cheap crude oil from the Soviet

Union. The oil was used in the country's refineries and thermoelectric power plants, with the surplus being re-exported to other markets for profit and stocks of foreign currencies.

All this came to an end with the abrupt breakdown of the Soviet Union in the early 1990s, which left Cuba in a deep economic crisis. Some macroeconomic data might illustrate the severity of the situation. Between 1989 and 1993 the level of GDP dropped by some 35 percent, whereas the level of unemployment raised by 8 percent (Mesa-Lago & Vidal-Alejandro, 2010). Physical production in most of the country's key agricultural and industrial products fell dramatically, whereas the fiscal deficit rose from 7.3 to 33.5 percent of GDP. Moreover, merchandise exports and imports both contracted by nearly 80 percent, and the country's international hard currency debt increased by approximately 42 percent (Perez-Lopez, 2002). Scarcities increased and shortages of almost any kind became commonplace, leaving conditions across the island in rapid deterioration. In short, the crisis threatened to undo thirty-five years of social gains and economic achievements.

In response, the government initiated austerity measures, officially named the 'Special Period in Time of Peace', aimed at reducing expenditures, perhaps best illustrated with a sharp reduction in energy consumption, and a plunge in real social expenditures per capita at 78 percent (Mesa-Lago & Vidal-Alejandro, 2010). Attempts were also made to diversify the structure of the economy by moving away from the production and export of goods with low technological intensity such as sugar and tobacco, to higher value-added services in health, education, and tourism (Jover et al., 2011). The authorities also reformed the foreign investment law, which made sense because Cuba lacked access to multinational financing sources, and had only very limited access to bilateral credit due to its foreign debt (Villanueva, 2012). Further, restricted self-employment in over 100 occupations, such as in home repair and transportation, agriculture, and in personal services such as in tourism were authorized (Perez-Lopez, 2002).

As for science and technology policies, efforts were made to establish a more comprehensive system, while maintaining the public expenditure on science, technology, and research and development close to one percent of GDP. In 1995 the official System of Science and Technological Innovation (SCIT), Cuba's formal equivalent to the National Innovation System, was established (Jover et al., 2011). As a result of the policy measures, Cuba managed an average GDP growth rate of 4.6 percent between 1996 and 2000, "a nearly-miraculous turnaround for an economy widely believed to be in the ropes in the early 1990s." (Perez-Lopez, 2002, p. 516).

3.1.2 Recent Developments

Although experiencing an overall growth rate in GDP, it has only been at a modest 3.2 percent since 1993 (Torres, In Press). Some of the economic changes initiated during the 1990s came to a halt in the early 2000s, in part helped by the willingness of Venezuela's president Hugo Chávez to supply Cuba with large amounts of petroleum in exchange with healthcare and other services. The beneficial agreement relieved the pressure on Cuban finances. For some years at least, the government could seemingly afford to misallocate resources and turn its back on efficiency and market principles (Domínguez, 2012).

In recent years, the failure to embark on a path of substantial and sustainable growth has been acknowledged by the top national leadership, however. In 2010 Cuba's new leader Raúl Castro stated that Cuba was in the need of a serious updating of its economic model (Castro, 2010). The global financial crisis had left Venezuelan resources sharply reduced, which yet again revealed the vulnerability of relying of external powers for national welfare. The statement was in fact in line with the reform measures Raúl had initiated since his ascendance to power in 2006/2008, and a sign of what was to come. Since his takeover Raúl had, among others, legalized private operations of *taxistas* and granted large acres of usufruct land to farmers and cooperatives. In April 2011 he summoned the Sixth Party Congress - the first since 1997 – aimed at securing the survival of Cuban socialism by addressing the low rates of productivity and efficiency in most sectors. The Cuban model was, in essence, not economically viable.

In 2011 the Congress approved a document drafted by the Party Congress titled 'Guidelines of the Economic and Social Policy of the Party and Revolution' (Sixth Congress of the Communist Party of Cuba, 2011). It is a detailed domestic policy blueprint that forms the basis of future reforms. It systematizes and formalizes the previous reform measures, and covers a wide range of areas. Further, it aims at changing the structure of employment by laying off a substantial amount of state-employed workers to various occupations in the private sector. Moreover - according to the document - local and small-scale private cooperatives will be allowed in some sectors and activities, whereas the number of state enterprises is to be reduced. In agriculture the state will allow more room for free market mechanisms and non-state producers. There will also be more room for private restaurants and rentals in tourism. The importance of foreign investment for inward transfers of capital, technology, and access to markets are restated. What is more, foreign investments are targeted

to create jobs and increase national production in strategic areas, even if there is no major benefit in terms of foreign exchange earnings.

3.1.3 Deep-rooted Problems

Despite the efforts, the reform measures have by many observers been characterized as slow and not substantial enough to address the core causes of Cuba's economic problems (Hershberg, In Press). The roots of the problems are deep, and perhaps have its origins in the long economic and political integration with the East Bloc economies during the Cold War (Brundenius in Torres, Triana, Monreal, & Brundenius, In Press). Through this relationship Cuba copied the economic planning model of the Soviet Union. This model was based on numbered targets that were to be met by the expansion of capital and labor, the traditional factors of production. The model diverted from Western growth models which, since Solow (1956), increasingly denoted the role of total factor productivity - or technological change - for economic growth. Adding to this has been a series of structural problems, and low utilization of the country's relatively high levels of human capital, which current policies have been unable to address in a sufficient manner (Torres, In Press).

The latter point also seems to be the case when considering the nation's science, technology, and innovation policy which, despite significant successes in areas such as the biotechnology sector, is still associated with substantial flaws (Jover & Arriete, In Press). First, the linkages between research entities and productive sectors are still weak and based on an obsolete linear "science push" model which has been hegemonic in Cuban STI policy for the past 50 years. Second, the STI policy is still lacking an explicit policy for technology transfer, making transferred technologies determined by government decisions tied to international trade and investments. Third, the SCIT is still associated with an insufficient legal and methodological basis. The strained economic situation has also led to lower levels of R&D funding than in previous years, while the low access to foreign currency financing – which pays for materials and specialized equipment – has curbed STI efforts. Finally, the country's strained finances have also led to problems related to knowledge flows through the Internet and other information networks (Jover & Arriete, In Press).

3.1.4 The U.S. Embargo

Adding to these factors, which are domestic in nature, the longstanding standoff with the U.S. has constrained Cuba's economic options in a number of ways. Parts of it has been imposed

since October 1960 after Cuban authorities nationalized the properties of U.S. citizens and corporations, and was widened to a near-total embargo in 1962. The commercial, economic, and financial embargo was codified into U.S. law in 1992, and further broadened through the Helms-Burton act, passed by the U.S Congress in 1996. The embargo applies to almost all transactions involving Cuba or Cuban enterprises, and prohibits U.S. 'persons'[7] from participating in such transactions unless they have obtained a specific license from the U.S. Department of Treasury. The embargo also applies to subsidiaries of U.S. enterprises, and entities deemed to be owned or controlled by Cuba. Furthermore, U.S.-originated technology, U.S.-originated goods, and many goods produced with U.S.-originated components or technology cannot be transferred to Cuba or used in operations in Cuba. The Helms-Burton act also authorizes sanctions on individuals or entities that profits from or participates in property that was confiscated from U.S. nationals or have become U.S. nationals, although no lawsuits has been filed to date. In practice the embargo seals off access to Cuba's most natural trading partner in the developed world. It also constrains potential foreign investors and trade partners from other countries by imposing heavy sanctions on firms that do business in Cuba (Hershberg, In Press).

In summary, Cuba is on the path of slow economic and institutional transformation, although most scholars agree that the implemented and planned upgrading of the economic model is not substantial enough to address the core causes of the economic problems. The longstanding U.S. embargo has been an obstacle for Cuban development efforts, but is only a contributing factor. According to Brundenius (2009) Cuba's growth performance was for many years relatively successful, at least in a Latin-American context. From the mid-1980s, however, the economic model was stagnating, and struggling to produce growth (Brundenius, 2009).

3.2 THE PETROLEUM INDUSTRY

The oil and gas industry is associated with high economic risk, particularly in upstream operations. Despite the fact that innovations in seismic and other areas have made field-characterizations more reliable than in earlier periods, economic evaluations still need to calculate for a variety of uncertainties. These can be related to costs, the probability of finding and producing economically viable reservoirs, technology, and oil price. This is all the more

[7] U.S. 'persons' include U.S. citizens, U.S. residents, individuals or enterprises located in the United States, enterprises organized under U.S. laws, and enterprises owned by any of the foregoing.

urgent when considering the large capital investments required upfront in such operations, particularly offshore.

Further down the chain, on the development and production stages, uncertainties take other forms. Here, they are related to infrastructure, production schedule, the quality of the petroleum, operational costs, reservoir characteristics, and others. In sum, despite considerable technological innovations, no blueprint is given for the successful discovery and development of hydrocarbon resources (Suslick, Schiozer, & Rodriguez, 2009).

Still, the market price for oil and gas has historically been way above the price required to keep the factors of production in active use, and also above the price required to make profits out of the operations. Thus, despite the high requirements of capital and technological master along with the considerable economic risk, the petroleum industry is one where large economic rents can be earned (Ryggvik, 2010; Vivoda, 2009).

3.2.1 Historical Developments

Because of the high levels of capital and technology needed to extract and produce hydrocarbons (Humphreys et al., 2007), countries rich in petroleum resources typically find themselves in need to seek the expertise of foreign oil companies to extract and process their hydrocarbon resources. Historically, the distribution of economic rents has been a subject of fierce bargaining between various international oil companies and petroleum-rich developing countries (Stevens, 2008). During the first decades of the 20th century, a few major international companies dominated the scene. These are often referred to as the 'Seven Sisters'. Using their modern names they were Exxon Mobil (US), Chevron (US), Gulf of Texaco (US), BP (Britain), Shell (Britain-The Netherlands), and CFP (France). Through the secret 'As Is' agreement of 1928, the Sisters left aside their main differences and carved up the world oil market between them.

The international oil companies were often backed by their respective national governments which, since the decision of Winston Churchill in 1912 to convert the British navy from coal to oil, increasingly saw the securement of oil supplies as a top national priority. According to Ryggvik (2010, p. 53) the international oil companies secured ownership of oil fields through the application of a variety of measures. These spanned from bribery of corrupt politicians or officers to outright toppling of 'hostile' governments. As a result, the share of petroleum rents accruing to host states was typically limited to salary payments, small compensation to land owners, and briberies.

The balance of power shifted, however, when oil producing states in the Middle East and elsewhere increasingly regained control of their resources. According to Stevens (2008) there were three main reasons for this shift. First, the concept of 'permanent sovereignty' over national resources was on the rise in intergovernmental organizations and elsewhere, marked among others by a series of resolutions passed by the United Nations during the 1950s and 1960s. The resolutions advised host states to acquire full control of their natural resources in order to exploit their fields maximally. Second, among host states there was a growing dissatisfaction with the oil concessions signed before World War II. In short, these contracts were designed so that the international oil companies secured large rents, at financially very favorable terms, without much effort, for many decades. As an example, in Iran, Iraq, Kuwait, and Saudi Arabia – all major producers – the average life of these concession contracts were 82 years. Finally, there was a rapid increase in the demand for oil in the U.S. and European markets, which made the oil fields of the Middle East unprecedentedly important. The rise in demand also created niches in the market for smaller oil companies that were more willing to accept the new economic demands posed by Middle Eastern oil states (Engen, 2009).

The resulting resource nationalism corresponded with a view that gradually gained ground in many oil producing states: in order to reduce their dependence on the international oil companies, they had to develop domestic technological capabilities to be able to negotiate better deals and run their oil fields without foreign assistance. Two measures were taken to this end. First, the oil states established publicly owned national oil companies to gain expertize and secure direct state participation within the oil industry. Second, the major exporting countries decided to cooperate on matters of mutual interest, which was formalized through the creation of OPEC in 1960. Throughout the decade cooperation was further institutionalized, and major exports countries were able to renegotiate their concession contracts or, in some cases, nationalize the entire industry (Tordo et al., 2011, p. 18).

The shift in the balance of power was thoroughly marked with the selective oil embargo of key Arab exporters against Western nations in 1973, which triggered a quadrupling of oil prices. By 1976 the old style concession system had been swept away, and the producer governments of the Middle East had full control of their oil operations and oil prices (Stevens, 2008). Moreover, the wave of resource nationalism further spread throughout the developing world, making the 1970s the peak decade of this trend. Outside the U.S, Canada, and the centrally planned economies; from 1973 to 1975 public sector control in the oil industry rose from 9 percent to 62 percent in production, from 14 percent to 24 percent in refining, and from 11 percent to 21 percent in marketing (Heller, 1980). The oil rich countries

still lacked capabilities in downstream operations, however, such as in refining and access to markets. As a consequence the international oil companies still exercised considerable leverage in downstream operations in many developing countries (Ryggvik, 2010, pp. 57–62).

Although the wave of resource nationalism had tipped the balance of power in favor of oil producing states, the oil price shocks and large revenues gathered throughout the 1970s had left considerations of enhanced domestic capabilities less urgent. In the wider economic and social debate, state owned enterprises were subject to increasing attacks for their lack of efficiency and poor results compared to their private counterparts (Tordo et al., 2011, p. 19).

Further, the discourse of privatization and liberalization that characterized the 1980s and 1990s made many countries more sympathetic toward FDI, a trend that increased the competition for the technology and expertise of international oil companies. Foreign participation became especially urgent after 1986 when the oil prices dropped abruptly as the delegates of OPEC had failed to keep the production levels at agreed upon quotas. In addition, the oil appeared to be coming out of more difficult geography and geology. In sum, these factors made the international oil industry move from a seller's to a buyer's marked, and a series of governments reopened their upstream sectors for foreign participation, at relatively favorable terms. In the early 1990s the opening of the petroleum fields in former East Bloc countries further decreased the competitive position of the oil-producing (Stevens, 2008). All this pointed to a shift in the balance of power towards the international oil companies.

Since the turn of the millennium, the balance of power has tilted in favor of the host states yet again. After a collapse in 1998 the international market price for oil has reached unprecedentedly high levels. Competition among international oil companies became fiercer towards the end of the century, which led to a larger emphasis on value-based management of the oil companies. In effect this means that the companies are valued in terms of their rate of return, favoring short-term value creation for shareholders. As a consequence, investments fell steadily, especially after 1998 (Stevens, 2008). In combination with the rise in demand in East Asian markets and new geopolitical uncertainties, the low level of supply-side investments swelled prices. This has led many host states to rethink their contracts, seeking higher taxes, royalties, and increased local industry participation through local content demands (Accenture, 2008; Vivoda, 2009). In addition many national oil companies have emerged as serious competitors, both at home and abroad.

As a result of the waves of resource nationalism, oil producing states now own and control between 77 and 90 percent of the total proven oil reserves worldwide, with similar numbers applying to gas (Tordo et al., 2011). In the next 20 years an estimated 90 percent of

new hydrocarbon production will come from developing countries (Baker III Institute, 2007). The international oil companies on the other hand, have full access to countries with only six percent of the proven resources worldwide, and an opportunity to engage in joint ventures or product sharing agreements in countries that own an additional 11 percent (Mouawad, 2006). Overall, the situation has made peripheral areas, such as in deep- and ultra-deep waters more attractive for oil companies of various origins and sizes.

3.3 NORWAY'S PETROLEUM SECTOR

Norway's offshore based petroleum industry is the first sector that will be used as comparative material in the analysis. Like Cuba today, Norway is a small state that sought the participation of foreign oil companies in a period where the balance of power generally favored host states. Norway is, however, frequently ranked among the top nations in measures such as GDP per capita (IMF, 2012a) and HDI (UNDP, 2013),[8] and is often characterized as the prime example of a country that has managed to turn its natural resources into economic and social growth and development.

3.3.1 Existing Capabilities and the International Context

Before offshore exploration began in the late-1960s, Norway did not have an existing petroleum sector such as the onshore-based sector of Cuba. It had, however, a certain absorptive capacity through three established industrial groups (Engen, 2009). First, Norwegian shipbuilders had become increasingly specialized during the late-1960s, and could in cooperation undertake complex operations, such as constructing oil rigs and platforms. Second, there existed a group of private ship-owners who had had prior experience with the international petroleum industry through the ownership of tankers. Further, Norwegian financial organizations had interests in Norwegian shipyards and the shipbuilding industry. Third, the chemical giant Norsk Hydro had international links to the petroleum industry, and began to build up an internal staff with offshore expertize in the mid-1960s. Nevertheless, like Cuba today and Angola in the 1970s, the industrial base was not in any way capable of operating an offshore petroleum sector without foreign involvement (Engen, 2009).

On the institutional side, Norway benefited from having prior experience in the granting of concessions and taxation of natural resources. This had been developed through

[8] Its nominal GDP totaled $501.582 billion in 2012, whereas its GDP per capita was at $99,664 (IMF, 2012a). Its level of HDI was measured at 0.955, ranking the nation at the very top (UNDP, 2013).

the concession system for hydroelectricity, crafted some fifty years before. Just as in Cuba and Angola, the dependence on foreign participation in the petroleum sector was well-recognized by Norwegian authorities early on. In consequence, Norway sought to maximize foreign participation at the initial stages, partly at the expense of domestic actors such as Norsk Hydro (Ryggvik, 2010, p. 73).

As stated, the international context was rather favoring host states in the 1960s and 1970s. The threat posed by rising resource nationalism made both major and smaller oil companies looking for promising and politically stable regions. As such the North Sea was perceived as attractive, particularly after natural gas was found near Groningen (the Netherlands) and off the South-East coast of Great Britain some years before. The North Sea was also located close to the rising markets of Europe. Thus: "On the whole […] the broader changes in the international environment strengthened the bargaining position of the Norwegian government and Norwegian firms in the early development of the oil industry." (Engen, 2009, pp. 184–85).

3.3.2 Creation of Statoil and Early Sectoral Policies

Neither the international oil companies nor the Norwegians had any prior experience with drilling for oil and gas in the North Sea. At the outset, the international oil companies preferred light platform designs and sub-sea solutions with little involvement from Norwegian sub-contractors. This stood in opposition to the goals of Norwegian authorities, who outlined a petroleum technology policy that implied the highest possible participation of Norwegian industry (Engen, 2009). In the eyes of Norwegian authorities, this was seen as essential to secure the largest share of petroleum rents possible.

In effect, the concession system was shaped to make it politically advantageous for the internationals to engage Norwegian firms in the process. The system also shaped the technological and organizational trajectory of the industry, as illustrated with the agreement to use Norwegian concrete technology in the construction of offshore platforms (Engen, 2009). Further, Norway's policy of slow depletion was designed to give Norwegian oil companies and suppliers time to develop indigenous industry capabilities, a policy that lasted into the 1980s.

Through Statoil, the national oil company created in 1972, national political control of the oil sector was sought achieved by mastering all aspects of petroleum industry operations. The rationale behind Statoil's further development largely followed these goals (Ryggvik,

2010, p. 96). Statoil soon became an important instrument in dealings with the internationals: "Agreements regarding training and transfers of knowledge and technology from other companies were negotiated, and Statoil itself took the role of intermediary in delegating tasks to Norwegian industry." (Engen, 2009, p. 185). Statoil's powers were limited, however, by the petroleum industry competence base that was developed in the Norwegian Petroleum Directorate (NPD). The NPD was established as an advisory organ for the Ministry of Oil and Energy, the latter which held the role as concessionaire and maintained the overall political responsibility of the sector (Ryggvik, 2010, p. 97).

3.3.3 Development of a Domestic Petroleum Innovation System

The favorable international context, as well as a domestic effort to build indigenous competencies had reduced some of the asymmetries that existed between Norwegian and foreign actors. Nevertheless, it took 32 exploratory wells before any major reservoirs were discovered (Store Norske Leksikon, 2005). Once discovered the agreement by Phillips and other internationals to approach the policy demands of Norwegian authorities in a flexible manner was eased (Figure 3.1 and 3.2). In addition, any concerns about cost explosions, whether due to lack of prior experience or choice of solutions that fitted the domestic industry, were swept away by the quadrupling of the prices in 1973 (Engen, 2009).

In the late-1970s Norwegian actors were brought into the center of operations through the development of the Condeep-platforms, which were large gravity platforms placed on the seabed. The complex set-up of these platforms required the various oil companies, suppliers, sub-contractors and authorities to build up large bureaucracies in order to control each other, and the number of Norwegian stakeholders in the petroleum industry expanded significantly. Although cumbersome and costly, the result was increased competence and linkage building among the actors.

Throughout the 1980s international and domestic linkages were further developed, which increasingly also included indigenous research capabilities. Again the government provided incentives for domestic capability building by so-called 'goodwill agreements'. Here international petroleum companies gained 'goodwill points' by contracting with Norwegian firms and research institutes, and through the transfer of technology. The contribution of foreign companies to domestic capability building was monitored and reflected in the next concession rounds (Sæther et al., 2011).

It was in this period that Statoil became capable of operating offshore fields independently through an agreement with the American oil company Mobil (Ryggvik, 2010, p. 108). This proved crucial for the relative bargaining power of Norway as a host state. From now on, in various bargaining processes, foreign oil companies could not effectively threaten to pull out to grasp a higher share of the petroleum rent, simply because Statoil then take over and do the job (Ryggvik, 2010, p. 113). Through the longstanding and targeted technology policy of Norwegian authorizes; to facilitate inward transfers and develop the capabilities of Statoil and other actors, Norway had significantly increased its relative bargaining power versus the foreign oil companies investing in its petroleum sector. The process suggests a circular causality between host state relative bargaining power and capabilities as suggested by figure 2.5.

Further, with the inclusion and development of Norwegian research capabilities, and the increased linkages among the actors, the Norwegian petroleum innovation system had matured from its early phases (Engen, 2009). Through substantial policy efforts, linkages had been established between a wide range of domestic and international firm and non-firm organizations, resulting in significant capability increases among domestic petroleum sector actors. In other words, the Norwegian petroleum innovation system had evolved from an emergent to a mature system, as illustrated by Figure 2.3.

Even though the system at this stage was internationally uncompetitive, the sharp decline in oil prices from 1986 on led to a reorganization of the sector, aimed at reducing costs by 50 percent. Firms were given greater independence in the planning and implementation of alternative technological solutions than in the earlier phases of the industry. Through increased R&D funding, both from public and private sources, new technologies were introduced, among others in recovery and development of the oil fields. The new post-Condeep technical concepts also required simplified organizational models, which along with the introduction of computer-based solutions and unmanned installations further reduced the costs, and laid the foundation for the internationalization of the Norwegian petroleum industry in the past two decades (Engen, 2009).

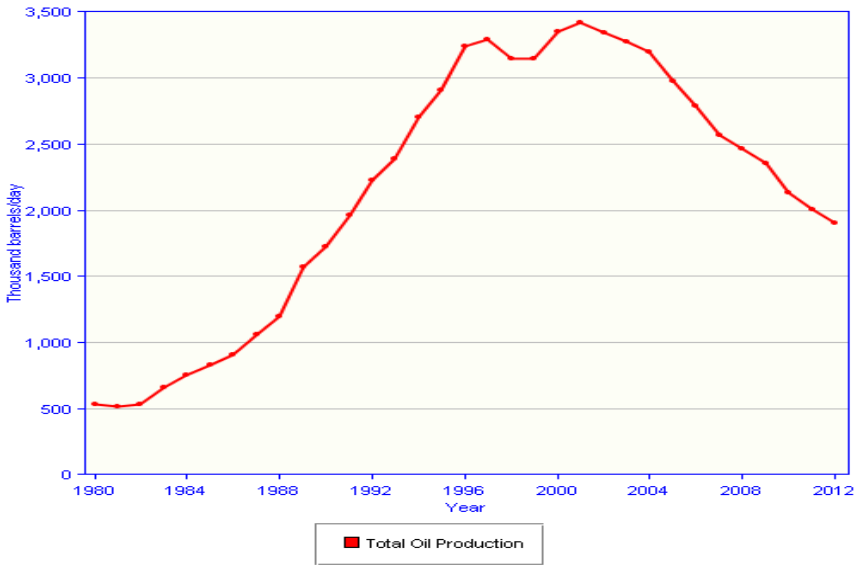


Figure 3.1: Total oil production in Norway, 1980 – 2012, thousand bbl/d, (EIA, 2012a).

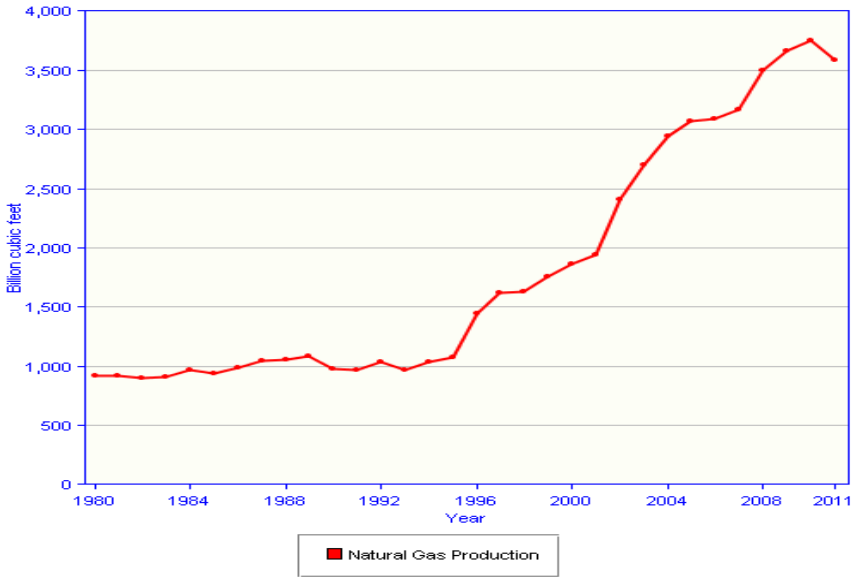


Figure 3.2: Total production of natural gas in Norway, 1980-2011, billion cubic feet, (EIA, 2012a).

3.4 ANGOLA'S PETROLEUM SECTOR

Angola's offshore oil-based petroleum industry is the second sector to be drawn on in the analysis. Similarly to Norway and Cuba, Angola is a small country, with a population reaching approximately 18.5 million. Angola differs substantially from Norway most other indicators, however. According to the International Monetary Fund its nominal GDP totaled $118.719 billion in 2012, whereas its GDP per capita was at $5,873, ranking it as number 107 (IMF, 2012b). Its level of HDI was measured at 0.508 in 2012, categorizing Angola among the countries with low human development by the United Nations Development Programme (UNDP, 2013).

3.4.1 Early Developments

Angola started extracting oil in the 1950s, and oil had prior to its independence from Portugal in 1975 become a major export, reaching 150,000 bbl/d. This was by and large conducted by foreign oil companies, such as Angol, a subsidiary of Portugal's Sacor, or Cabinda Gulf Oil Company Limited, a subsidiary of America Gulf Oil. Although the leftist MPLA movement seized power in November that year, the country was torn by rival factions until 2002. The MPLA officially adopted Marxist-Leninism in 1976, expropriated Portuguese propriety, and introduced central planning of the economy. The oil sector was, however, largely sheltered from the political storm because of its apparent revenue-generating abilities, and has since been a trustworthy source of income to the Angolan presidency (De Oliveira, 2007).

The successful development of the Angolan petroleum sector was far from apparent at the outset. By the mid-1970s the vast majority of educated and technically able personnel had fled, and the country lacked the appropriate infrastructure and regulatory oversight needed to operate a well-functioning energy sector (EIA, 2013a). This was in contrast to Norway which, despite lacking in petroleum sector experience, had both industrial and institutional competences to build on. Nevertheless, a commission of MPLA-backed businessmen, engineers and other technical experts managed the transition of the oil sector to national hands in a relatively smooth manner.

From the start, the necessity of foreign participation in the sector was recognized as fundamental, as Angola alone did not have the capability to explore and produce offshore-based oil by itself. Foreign participation was welcomed, despite the general wave of resource nationalism and anti-imperialistic sentiments characterizing the international oil industry at the time. The American Gulf Oil subsidiary Cabinda Gulf Oil Company Limited, which had exited in 1975, was lured back. This was achieved by a combination of assurances of pragmatic and business-minded intensions on the Angolan side, and pressure from Nigeria, which hinted at retaliation against Gulf's interests in the Niger Delta should Gulf boycott the new state (De Oliveira, 2007). Further, the luring back was achieved despite the fact that the leftist orientation of the new state had made it a sworn enemy of the U.S., Gulf's home country, but again in an international context where the international companies found it increasingly harder to access the oil fields of many nations. Other countries which had operated prior to 1975, such as Petrofina and Texaco were also encouraged to return, while nationalization of the oil sector was explicitly ruled out by the Angolan leadership.

3.4.2 Creation and Development of Sonangol

The only exception to this rule was the takeover of the Portuguese oil company Angol in 1976. This formed the basis of Sonangol, Angola's NOC which since 1978 has been the sole concessionaire, sector regulator, and tax gathering agent in Angola's oil industry (EIA, 2013a). Due to the paucity of human resources, Sonangol prioritized contractual negotiations with the foreign oil companies, while the latter would remain responsible for exploration and production. Sonangol partnered with the Algerian NOC Sonatrach in 1976, which besides giving advice in contractual negotiations also trained a considerable number of first-generation Angolan personnel. Italy's ENI also played a role in providing technical education. In addition the Cambridge, Massachusetts consulting firm Arthur D. Little became a major source of apprenticeship (De Oliveira, 2007).

As a consequence, Sonangol managed to develop and uphold a continuity of technicians, enlarged by new legal, engineering, geological, and economic expertise, and was by the beginning of the 1990s the leading domestic entity in Angola's political economy. In 1991 Sonangol was restructured into a holding company, and has since developed a large number of subsidiaries concerned with both core and non-core businesses. The subsidiaries are treated preferentially in the procurement of goods and services to oil companies operating in Angola (Alvesson, Bhattarai, & Pastor, 2003). Through its subsidiaries Sonangol has operations in upstream, downstream, and midstream activities, in later years increasingly also in gas.

3.4.3 Continued Openness

The emphasis on foreign participation has in later years not only been confined to contractual negotiations. A growing number of joint ventures have been established in various activities throughout the petroleum sector value chain. Three factors have been especially important for the successful openness to foreign participation in the sector. First, and increasingly over the years, the oil of Angola has been seen as very attractive among foreign private and public oil companies. The production output has steadily increased since the independence (Figure 3.3 and 3.4), and the light and sweet quality of the crude makes it well-fitted for large export markets such as China and the U.S. (EIA, 2013a).

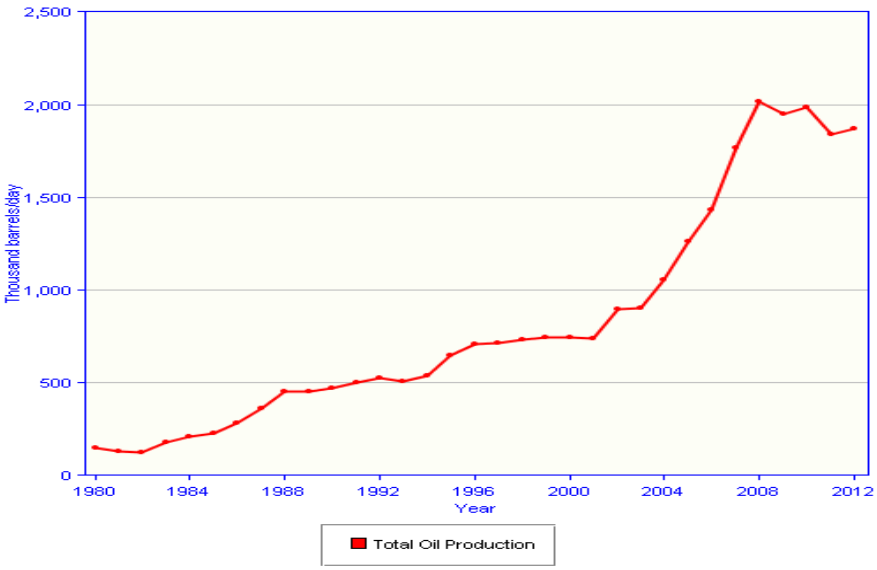


Figure 3.3: Total oil production in Angola, 1980-2012, thousand barrels of oil a day (bbl/d), (EIA, 2013a).

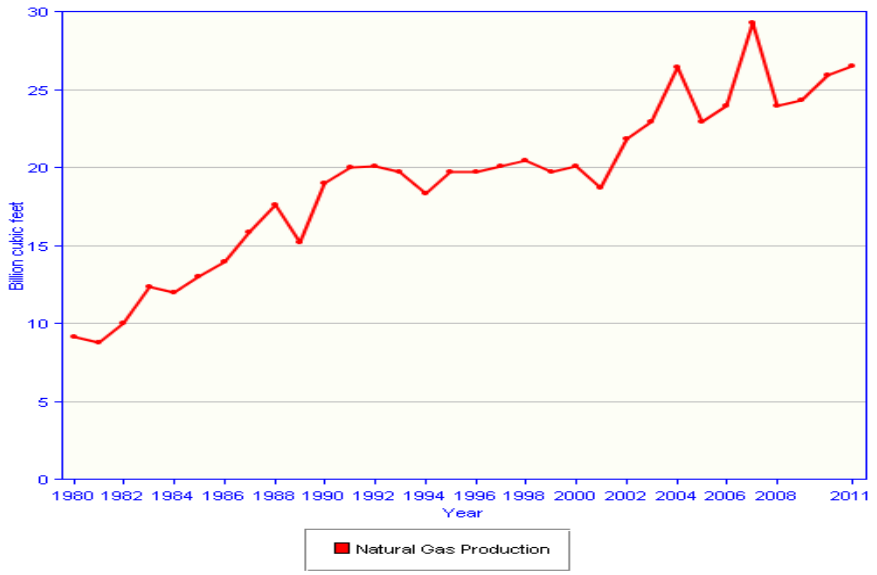


Figure 3.4: Total production of natural gas in Angola, 1980-2011, billion cubic feet, (EIA, 2013a).

Although the bulk of Angolan oil is located offshore, technological innovations have made it possible to access oil in deep and ultra-deep waters. After large reservoirs were found in ultra-deep waters by Elf in 1996, Angola quickly became the hotspot for companies such as BP, Royal Dutch/Shell, ExxonMobil, Statoil, Petrobras, CNOOOC, and Sinopec.

Second, from the point of view of the foreign oil companies, the interactions with Sonangol have been relatively hassle-free. As mentioned, the oil sector of Angola has been sheltered from the rest of the economy, which in contrast is characterized as one of the riskiest economies worldwide in which to invest (De Oliveira, 2007). According to the International

Energy Agency no less than US$ 17 and US$ 23 billion of FDI was poured into the Angolan petroleum sector between 2003 and 2008 (IEA, 2006).

Third, by leveraging its role as a concessionaire Sonangol has served as a main vehicle for enhancing local participation (Tordo et al., 2011). Training programs of Angolan personnel are required from all oil companies operating in Angola, which is expected to provide US$ 200,000 per year per block during the exploration phase, and US$ 0.15 per barrel of oil during production.

Although the requirement of a minimum 70 percent of Angolans in oil operations are rarely met, and domestic capabilities in non-firm organizations seems very limited, the government hopes these programs will increase the technical capability of its domestic workforce (EIA, 2013a). In the meantime Sonangol, through its various subsidiaries are building capabilities through various interactions with foreign companies. Perhaps most notably is the capability development of Sonangol P&P, which now operates several onshore and offshore fields in Angolan territory.

Recent issues, such as revisions of the Angolan Petroleum Law to increase local content, wishes by Sonangol to slow project developments, and demands for ever-more substantial sign-on bonuses have been contentious (De Oliveira, 2007). However, they have also marked the relative bargaining power and competence of Sonangol, which put it in a more equitable position vis-à-vis the foreign operators, thus signifying a circular causality between host state relative bargaining power and capabilities in the case of Angola as well.

3.5 SUMMARY: NORWAY AND ANGOLA

As hinted on from the preceding sections on the petroleum sectors of Norway and Angola, some common factors for successful sectoral development might be identified.

As for bargaining power, both countries heavily depended on the resources of foreign oil companies for extracting and producing petroleum resources. In terms of basic entry conditions, Angola benefitted from having proved resources, with an export level of 100,000 bbl/d in 1973. In Norway, it took a number of exploratory wells before any major fields were discovered, but with Ekofisk – at the time the largest offshore petroleum discovery ever made – the basic entry conditions were firmly in place for future bargaining.

Similarly, as explored in section 3.2.1 both countries benefitted from a favorable international context on most indicators. This was particularly the case after the quadrupling of oil prices in 1973.

As for host country contextual factors, the two countries differed significantly on a number of indicators, such as in level of economic development and relative dependence of the domestic economy on FDI. This also seems to have been the case when considering various investment risks for foreign contractors. However, despite the adoption of Marxist-Leninism by the MPLA in 1976, which spread fear of expropriation, and a decades-long civil war, the petroleum sector was largely sheltered in Angola. Thus, both countries by and large managed to offer what was perceived as sufficient investment climates in the eyes of the foreign oil companies.

As for petroleum technology policy, the authorities of both countries have favored a high degree of openness for foreign participation in the petroleum sector. Both have aimed at accessing inward transfers of technology and knowledge held by foreign actors, while correspondingly developing domestic capabilities in domestic actors in the petroleum industry. In the case of Angola, however, due to a lack of absorptive capacity in domestic actors, this line of policy towards foreign oil companies only seem to have been substantially pursued in later years, and seem by and large to be limited to Sonangol and its subsidiaries.

In both cases, the circular causality between host state relative bargaining power and capabilities seems to have manifested itself and made a positive contribution to the development of the respective petroleum sectors of the two countries. In particular, the capability building in the respective national oil companies Statoil and Sonangol has contributed to this.

4. METHODOLOGY

This chapter presents the methodological outline of this thesis. I will start out by giving a brief description of the case study research method and justify why this type of method has been applied to study Cuba's petroleum sector. I will then present an outline of the research design. This is done to give a transparent account of the various steps of the study. Subsequently I provide a discussion of the applied data collection sources and discuss why they were chosen. I will then go on to describe how I collected and analyzed the empirical data, before I discuss various biases and limitations of the chosen methods, empirical data, and analysis. The chapter ends with a brief discussion of ethical considerations.

The goal of this chapter is to provide the reader with a transparent account of how the data was collected, processed, and analyzed. In doing so it is my hope that the reader can clearly assess the validity and reliability of the research process and findings.

4.1 THE CASE STUDY

4.1.1 Why a Case Study?

The research questions posed in this thesis are so-called "what" questions aimed at exploring different processes and characteristics of Cuba's petroleum industry. According to Yin (2009) questions of this type might use several different research methods, including the case study method (Yin, 2009, p. 9). Case study research is well suited to discover nuances, contextual influences on and explanations of a phenomenon, and is often used to "delve into under-theorized phenomena." (Baxter, 2010, p. 89). As such case studies can be used to test, falsify, expand, or generate explanatory theoretical concepts. Case study research does not discriminate between different types of data collection methods. In contrast, different kinds of qualitative and quantitative methods can be utilized to shed light on the phenomenon under study (Baxter, 2010; Punch, 2005; Yin, 2009). The emphasis of case study research lies not on the choice of data collection method but in that one case "will be studied in detail, using whatever methods seem appropriate." (Punch, 2005, p. 144).

Due to the scarcity of previous research and available data on the topic, the case study approach suits the objective of this thesis. It allows for an exploration of different aspects of Cuba's petroleum sector and takes contextual factors into account. In addition, the emphasis on the complementarity of different data collection methods makes the case study especially suitable here, as no source of data could single-handedly offer a sufficient amount of data for a proper analysis of the phenomenon in question.

4.1.2 Research Design

Case study research possesses no codification of research design that is generally accepted and fitting for all cases. This is not to say that design considerations are neglected in this approach. On the contrary, the inclusion of certain steps in the research is seen as crucial in order to advance from the initial research questions to their concluding answers, and to make sure that the evidence firmly address the research questions (Yin, 2009, pp. 25–27). As such, Figure 4.1 outlines the main steps of my research design.

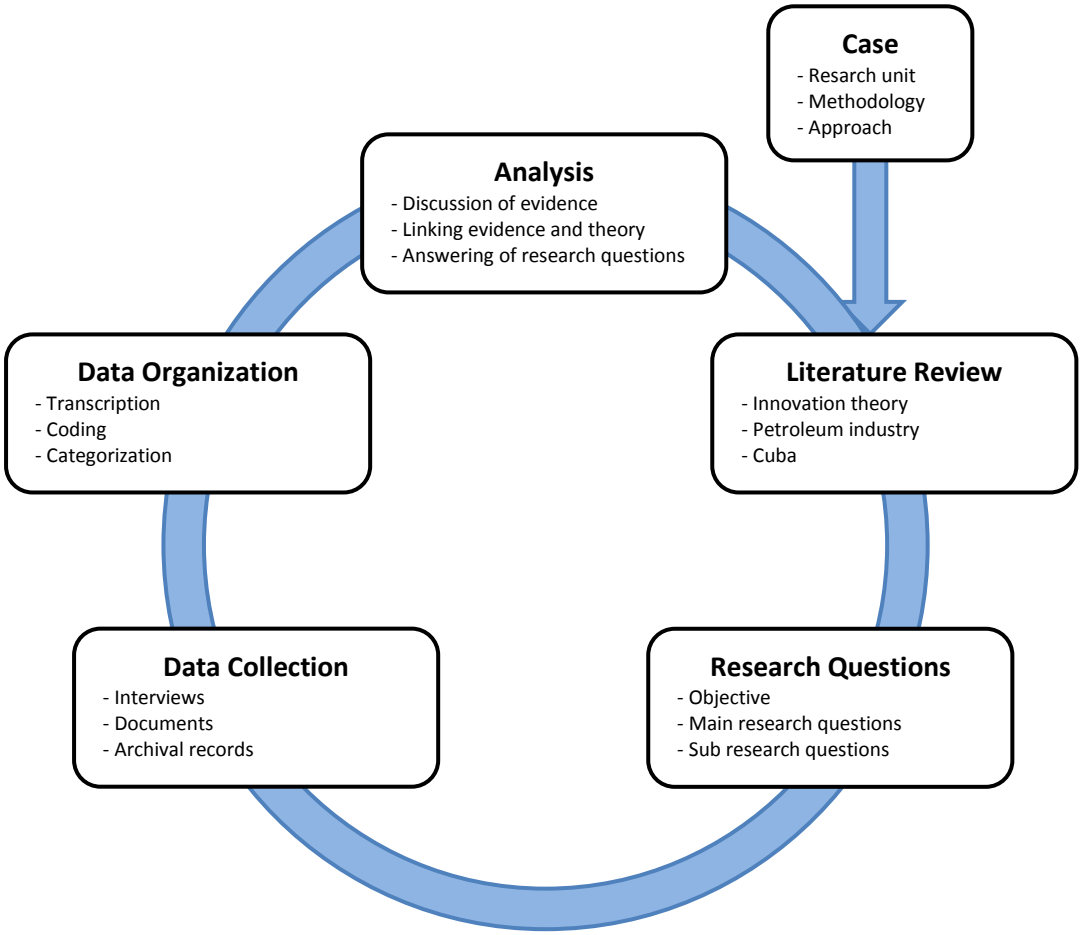


Figure 4.1: The research design of this thesis.

The general topic of my thesis was outlined by the ongoing NUPI project "Cuba phase 2: Economic and Institutional Reform in Cuba" (NUPI, 2011). I was given the opportunity to choose my topic of preference within this framework. After choosing the case of study – Cuba's petroleum industry – I conducted a thorough literature review spanning three broad areas: innovation theory, the petroleum industry, and Cuba. The literature review was

conducted to identify relevant and well founded research questions. The research questions then guided the data collecting procedures, where I found that different sources of data had to be accessed in order to increase the validity of the study. As data were collected I organized it through transcriptions (interviews), and otherwise by thematic categorization. Finally the data was analyzed in order to answer the research questions and address their theoretical implications.

Although the research design in Figure 4.1 is depicted as a neat process with clear-cut stages, in reality the procedure could better be characterized as a process of zigzagging back and forth between the different stages as the project proceeded. For example, during the data collection process, it became clear what kind of questions that could and could not be answered based on the available material. This lead to revisions of the research questions, and shifts in emphasis to other parts of the literature than what was originally planned. As the research progressed, I increasingly favored a broad approach, aiming at studying the case from several different angels and theoretical frameworks.

4.1.3 The Unit of Analysis

The unit of analysis in this thesis is Cuba's petroleum sector. I have chosen not to delimit the unit by focusing on a specific part of the system, or a particular stage of the value chain. Rather, I have maintained a holistic approach by emphasizing linkages between the constituents of the sectoral system, and between the different actors and stages of the chain.

That being said, I have narrowed the analysis of Cuba's petroleum sector by choosing specific research questions, and by selecting certain theoretical frameworks to guide my analysis. As such, certain aspects of Cuba's petroleum industry; inward transfers and domestic capability building have been emphasized at the expense of others features of the industry.

4.1.4 Validity and Reliability

In social research validity and reliability are contested concepts. In what follows, validity is understood as "the isomorphism (or otherwise) between the reality studied and the reality reported [in a study]." (Punch, 2005, p. 29). Following Punch (2005), several aspects of the concept need to be assessed: how well the data of the study represent the phenomena under study (*data validity*); how well the different parts of the study fit together (*overall validity of the research*); how well the study reflects the real-life phenomenon (*internal validity*); and to

what degree the findings can be generalized to other settings (*external validity*) (Punch, 2005, p. 29).

Throughout the research process I have sought to address these considerations using a variety of measures, as will be discussed in further detail in the sequences below. For now I will just address these issues briefly. The issue of the data validity of this thesis is discussed in different parts of this chapter. While collecting the data often proved challenging, I discuss the measures taken in order to enhance the validity of the data in section 4.5.

The overall validity of the research has been sought by maintaining a research design, recognizing the interconnection of the parts when making changes along the way. The internal validity of the study has been sought by applying operational concepts that are well-recognized in the research community, and by using multiple sources of evidence and participant checking where possible.

On the issue of the external validity of the findings it is acknowledged that N=1 studies like this one is not fitted to make statistical generalization. However, the findings address the theoretical concepts outlined in chapter 2, and might provide certain analytical generalizations (Baxter, 2010, p. 96; Kvale, 2007, p. 127; Yin, 2009, p. 43). These will be addressed in the concluding remarks of this thesis.

Reliability on the other hand refers to the consistency of the research, meaning that the results of a study could be reproduced by other researchers using the same instruments under the same circumstances (Yin, 2009, p. 45). Given that this type of study necessarily involves contextualized social interactions, true reliability is difficult – if not impossible – to achieve. Nevertheless, I have sought to offer a transparent account of the research process, the choices made, and why they were made throughout the chapter. In line with the recommendations of Yin (2009, pp. 45, 118-122), I also developed a case study database to enhance reliability (Appendix 3).

4.2 SOURCES OF DATA

In case study research, the high complementary between different sources of evidence are emphasized (Yin, 2009, pp. 6–8, 101). The use of different sources of data allows for the development of converging lines of inquiry through triangulation (Hammersley & Atkinson, 2007, pp. 183–5; Punch, 2005, pp. 184, 241; Yin, 2009, pp. 115–16). In this thesis I have

collected data from three different source categories: interviews, documentation, and archival records.[9]

4.2.1 Documentation and Archival Records

The findings of this study have relied on a broad range of documentation and archival records. They span from annual reports and presentations from different foreign petroleum companies operating in Cuba, and non-firm organizations such as Norad and Petrad. I have also reviewed statistical data published by the Cuban government, newspaper articles and formal studies covering the case under study, as well as internal records.

Documentation and archival records share many of the common strengths and weaknesses as sources of evidence. Their merits include that they are stable over time and exist independent of the case study. In addition they are generally exact in their description of events, names, and references. They can also cover a broad range of settings and events, over a long time-span. Archival records, such as publicly disclosed statistical data also have the advantage that they are usually precise and contain quantitative data (Yin, 2009, p. 102). Further, documentation and archival records can provide information about settings or their contexts, key figures, and organizations which might not be available from other sources. On other occasions they may provide corroboration or challenge data from other sources (Hammersley & Atkinson, 2007, p. 122).

As for the weaknesses of documentation and archival records, they can be difficult to retrieve and access, and selective due to biases of the author or incompleteness of the disclosed data. In addition, the purpose or targeted audience of the documents and archival records differs from those of the conducted case study (Yin, 2009, pp. 102, 105–6). These limitations require the researcher to evaluate the sources thoroughly. The researcher must firmly acknowledge that documentation and archival records are social products (Hammersley & Atkinson, 2007, pp. 130–33), and assess their authenticity, credibility, representativeness, and meaning (Jupp cited in Punch, 2005, p. 185).

4.2.2 Interviews

Interviews are commonly regarded as an essential source of case study data, as most case studies deal with human affairs or behavioral events (Yin, 2009, p. 108). The strengths of the

[9] Yin (2009, pp. 103, 105) provides an analytic distinction between documentation and archival records. *Documentation* include personal documents in various forms, written reports of events, administrative documents, formal studies or evaluations of the same "case", and different forms of news clippings. *Archival records* are "public use files" such as statistical data, service records, organizational records, maps and charts, and survey data.

interview method is that it focuses directly on the topics of the case study, and might provide detailed data upon which causal relationships and explanations can be inferred (Yin, 2009, p. 102). In addition, "own opinions and tentative conclusions can be checked, verified, and scrutinized." during interviews (Dunn, 2010, p. 103). On the other hand, interviews can be subject to different biases due to poorly articulated questions, response bias, poor recall, and reflexivity because the interviewee gives what he or she thinks the interviewer wants to hear (Yin, 2009, p. 102).

As is common in case study research, the interviews conducted in this thesis are more in the form of guided conversations than structured queries (Yin, 2009, p. 106). This form of semi-structured interviewing is recognized by a certain predetermined order, but is also flexible during the course of the interviews (Dunn, 2010, p. 102). After conducting the literature review I formulated a general interview schedule that covered all the main research themes of this thesis (Appendix 4). I sent the interview guide both to my supervisor and contact person in Cuba to ensure that they contained valid and well-formulated questions. I also included several secondary questions and prompts connected to each primary question.

I maintained a certain degree of flexibility in my interview design, however, by tailoring the guide to different interview subjects. Here some themes were highlighted whereas other sections were downplayed or even excluded from the guide. I always sent my interview guide to the subjects upfront in order to prompt thoughts on the themes to be discussed (Dunn, 2010, p. 105) and to obtain informed consent. The types of questions were primarily of a descriptive nature, aiming at obtaining valid factual information. In this regard the interviews might be categorized as factual interviews (Kvale, 2007, p. 71). Other questions were formulated to seek the opinions of the interview subjects (See Dunn, 2010, p. 106), such as their assessment of the main challenges for the development of indigenous capabilities in Cuba's petroleum industry.

4.3 COLLECTING THE DATA

Based on my literature review the collection of documents and archival records were done through key-word searches on digital databases, libraries, or search engines. I relied on a wide range of document types. As the process evolved I chose to broaden my search criteria to collect a higher amount of documentary evidence. For the main part of the collection process, the operating criterion for collection and review of documentary evidence was that it addressed the Cuban petroleum industry, its technology policy, institutions or organizations.

As I reviewed the documents and archival sources I picked up key words or references that were used in subsequent searches. I also relied on literature tips from informants, my supervisors, and other more peripheral persons in the research process. In addition, I received some documents from my field trip to Cuba that were not readily available through common digital searches (Yin, 2009, p. 103). Further, some of the documents and archival data were available in Spanish exclusively. In order to address the language barrier, I took an Internet-based Spanish course starting in the summer of 2012 and used dictionaries in the process of collecting this data. Although Spanish is still far from fluently mastered by this author, I do believe it made me able to identify and review these textual sources.

After reading through the documentary data I systemized their storage thematically in digital files on my laptop. Further, I developed a data base of the documents containing information about the author(s), title, a concise general description, and its application in this thesis (Appendix 3). This was done in order to make the collection of documentary evidence thoroughly conducted (Punch, 2005, pp. 252–53); by identifying strengths and weaknesses in the data, and to "make the documents readily retrievable for later inspection or perusal." (Yin, 2009, p. 120).

All in all I allocated relatively much time and effort reading and reviewing literature. It is my belief that this made more able to establish rapport with the interview subjects by producing an informed interview guide, and pose prompts and follow-up questions during the interviews.

The collection of interview data was initiated by a selection of informants based on my literature review, seminar-participations, and other background work. Here both central actors in Cuba's petroleum industry and knowledgeable researchers were identified and targeted as interview subjects. Additional subjects were targeted by asking people during seminars, e-mail correspondence, or interviews if they knew of other persons that could be interesting to interview about the case. This combination of sampling strategies, termed 'criterion sampling' and 'snowball sampling' respectively, is common in so-called purposive sampling (Patton (2002) cited in Bradshaw & Stratford, 2010, p. 75).

The negotiation process was mainly initiated with a formal letter of introduction by e-mail. In line with the recommendations of Dunn (2010) I sought to build report by introducing myself and establish my *bona fides* and general purposes of the research project in this phase. Further, I explained how I got their contact information, and why I wanted their insights on the case. I also attached a tailored interview guide to each of the targets to give an impression of the time-scope of the interview (Dunn, 2010, p. 113). The general interview guide was

moreover reviewed by my main contact person in Cuba to avoid undermining rapport at this stage.

As experienced by others doing research on Cuba (Plahte, 2010), however, in most cases accessing informants turned out to be very difficult to achieve. In particular this was experienced during my field trip to Cuba. The petroleum industry in Cuba is considered a highly strategic sector where only small amounts of data are publicly available. In the months before the trip I had asked several researchers with field trip experience in Cuba for advice and contact persons. I also visited the Norwegian embassy in Havana for potential interview subjects. While otherwise pleasant they could not offer me any additional contact persons than those that were already on my list.

On the other hand I established contact with a renowned Cuban economist attached to the NUPI project, who acted as my main contact person during the stay. This person helped me with my interview requests by sending them from his e-mail address, with introductory notes about me and the research project. He also provided me with several potential interview subjects. As such he also took the role of a gatekeeper in the process of accessing Cuban informants. It is my clear impression that I did not experience any surveillance or shepherding as can sometimes be exercised by gatekeepers (Hammersley & Atkinson, 2007, p. 51). On the contrary he was willing to provide me with his leverage, knowledge and social network. Although this type of interaction always entails some sort of channeling of the research project (Hammersley & Atkinson, 2007, p. 59), I felt that the new lines of inquiry that resulted from this interaction contributed to enhance the validity of the study.

Despite these measures, answers were either non-existent or slow, and did not substantiate into interviews before my departure back to Norway. In consequence I had to rely on interview subjects that were not part of the daily activities in Cuba's petroleum industry. As previously mentioned, very few external persons have in-depth-knowledge about the Cuban petroleum industry, and of the few foreign oil companies that have operated in Cuba, I was only able access one, despite repeated requests. This was on the other hand Sherritt International, which is the only foreign oil company operating in Cuba today.

I also contacted Statoil in this process, but since they were not the operator in the exploratory drilling well they had limited day-to-day experience with the Cuban petroleum sector. The operator of the exploratory well, Repsol, did not respond my requests.

However, the Norad-led Oil for Development initiative has had a Cuba program since 2011 which has included seminars and workshops addressing challenges related to deep water petroleum activities. Through Norad I managed to contact a senior executive officer involved

in the Cuba program. Although I also had scheduled an interview with one of the project directors in the Norad-affiliate Petrad, in the end nothing materialized from the negotiation process.

Most importantly, I got an in-depth interview with the Cuban-American oil researcher Jorge R. Piñón, who is associate director at The University of Texas at Austin – Center for International Energy and Environmental Policy. Judging from my literature review he is the most renowned expert on Cuba's petroleum industry, and knows the people in Cupet – Cuba's state-owned oil company - and petroleum ministry closely. As will become evident in the analysis, I relied quite extensively on the research and interview data collected from Piñón. Piñón is frequently used as (the only) source and expert on Cuba's petroleum sector in newspapers such as the New York Times, and was otherwise judged as very credible by various persons involved in the research process.

Nevertheless, it has to be stated that the dependence on Piñón is an issue for the data and internal validity of this thesis. Throughout the process I sought to counter this by triangulating the sources wherever possible, experiencing that they in large correlated highly with the evidence collected from other data sources.

Table 4.1 presents the different interviews conducted in this thesis.

Who	When	Interview Technique
Tonje Flatmark Sødal Higher Executive Officer, Norad	19.11.2012	Face-to-face with note taking, mail correspondence
Dr. Ricardo Torres Pérez Economist CEEC	31.07.2012 15.01.2013 28.01.2013	Face-to-face with note taking
Jorge R. Piñón Associate Director University of Texas	15.02.2013	Skype interview with audiotape recording
Sherritt Communications Department Sherritt International	05.04.2013	E-mail correspondence, answers attached to interview schedule

Table 4.1: Details of interviews conducted in the research project.

As for collection strategies I used several different in this thesis: informal face-to-face interviews with note-taking, phone interviews using Skype and the Amolto Call Recorder add on, and mail correspondence. I recorded the interviews using either audio-recording or note-taking, or a combination of the two. Both techniques are associated with different advantages and disadvantages. Audio recordings give the interviewer more time to prompt, formulate

new questions, and otherwise "maintain the conversational nature of the interview." (Dunn, 2010, p. 119). It will also give the most complete recording of the spoken words of the interview. On the other hand an audio recorder can also destroy rapport by making the informant nervous, and is also associated with certain technical risks (Kvale, 2007, pp. 93–94). Further, non-verbal data such as gestures and body language are not recorded on audio tapes. Note taking can counter some of these risks, but also put a great demand on the attention, and general craftsmanship of the note-taker. It also requires good shorthand writing skills, although note-taking can help to maintain the concentration of the interviewer, making him focus on the essence of what is said (Dunn, 2010, pp. 119–120).

In this thesis, audio recording was only used when I made the long distance call to Piñón. The interview was conducted with Skype, and automatically recorded through the Amolto Call Recorded add on.[10] The sound file was then uploaded to transcribe.wreally.com where I transcribed the interview into textual form.

According to Kvale (2007), when assessing the validity of transcripts they "are not copies or representations of some original reality, they are interpretative constructions that are useful tools for given purposes." In consequence "there is no true, objective transformation from the oral to the written mode." (Kvale, 2007, p. 98). Instead of asking 'what is a correct valid transcription?' one should strive to obtain a useful transcription for the purpose of the research. As the purpose of this interview was primarily to obtain the subject's account of factual information and characteristics, I did not include any specialized form of transcription. I did, however, strive to produce a detailed account of what was said during the interviews, including every word that was spoken, with pauses, hyphens and the like.

In the face-to-face interviews I chose to rely on note-taking as I would not risk alienating the subjects and undermine rapport. During these interviews I wrote down the key points of what was said, making arrows back-and-forth to connect sections and key-words. Immediately after the interview I elaborated on my notes in my note-book while the session was still fresh in mind. When I got access to my computer I transferred these notes to digital format. This repeating process allowed me to immerse with the data, and served as part of a preliminary analysis (Dunn, 2010, p. 121).

[10] As one key informant was situated in the U.S. I chose to do the interview through Skype. Skype charges NOK 83,97 for a 90 day period of calls to the United States, offering 400 minutes per month. Skype and the Amolto Call Recorder add on was tested repeatedly to ensure adequate sound and recording quality before any interviews were undertaken. The Skype interviews functioned as regular phone calls where I called to the subject's cell phone, thus minimizing the bias produced with visible audio recorders. Video recordings were not produced from these interviews.

A third form of interview technique that I applied was so-called asynchronous computer-mediated communication, or e-mail correspondence. This was vital all the time some of the interviewees were very distantly located. This technique can also help overcome social hurdles such as shyness and cautiousness, and is otherwise well-suited for sensitive topics. It also allows informants to choose the time of their responses, giving them time to produce reflective and detailed answers in written form (Dunn, 2010, pp. 129–130).

E-mail interviewing has, however, several pitfalls related to "the spatial and temporal displacements between the informants and the researcher." (Dunn, 2010, p. 130). It does not provide visual and contextual cues, delays prompts, and makes rapport building challenging due to the apparent gaps in communication. The latter point was experienced during this research project, when two informants after initially agreeing to answer the questions of the interview guide ceased to respond, despite several subsequent reminders. In general, however, I did try to address some of these concerns by providing detailed information and a tailored interview guide to the interviewees at the initial stages, while posing friendly reminders with at least one week in between. Although this type of negotiation often spanned several months, I finally received answers from one key source while using this method.

With the exception of the e-mail interviews, I sent the transcripts or notes that I wanted to use in my thesis for clarification and authorizing to the respondents that requested this. This process of participant checking (Dunn, 2010, p. 123) marked the final stage of the collection of interview data in this thesis.

4.4 ANALYSING THE DATA

The analysis of the collected documents and archival records was initiated by a process of data reduction where I highlighted phrases and key words that could inform the initial research questions and theoretical concepts. I chose to categorize the documents and archival records thematically in accordance with their topic and main content. While working with each document, I extracted the highlighted passages into different documents that sorted into new thematic categories. I then made attempts to provide tentative conclusions by addressing the research questions and theoretical framework.

The coding and categorization of data was by no means a linear process, however. Rather, it could be categorized as an act of recursive juggling (Cope, 2010, p. 285). As new evidence was collected and evaluated, new categories were established while others were altered or rendered obsolete. This process also extended to other part of the research design:

new evidence or the lack thereof led to modifications of the theoretical framework and corresponding research questions.

As an example, early on one of my main research questions concerned how increased innovative ability in the Cuban oil sector affected the overall innovative ability of the Cuban national innovation system. As it turned out, this research question was scrapped due to lack of accessible data, and a wish to focus the analysis more exclusively on the petroleum sector.

Similarly to the analysis of documents and archival records, the analysis of interview data did not follow any specific analytical method. Here I approached the transcripts pragmatically to identify key passages, themes, and opinions. According to Kvale (2007) this type of ad hoc analysis, where no systematic mode is followed, is termed bricolage, and is common in interview analysis (Kvale, 2007, p. 115). After the transcriptions were made I read through the interviews to get an overall impression of the accounts. When rereading them I coded by highlighting passages that were of particular value for the purpose of the research, identifying key concepts and information. I also divided the different passages thematically to see how they connected with my research questions, and how they supported, extended, or weakened empirical data from other sources.

4.5 BIASES AND LIMITATIONS

According to Hammersley and Atkinson's (2007) account on reflexivity, social research cannot be "carried out in some autonomous realm that is insulated from the wider society and from the biography of the researcher" (Hammersley & Atkinson, 2007, p. 15). This is connected to another epistemological point: that all research methods to some degree are subjective and value-laden (Winchester & Rofe, 2010, p. 16). In line with these views I do acknowledge that my orientations and values in certain ways have shaped the selection and findings of this study.

This is not to say that there are no strategies that can be followed in order to reduce the bias of a study, however. Yin (2009) states that one test of selection bias is to assess your degree of openness to contrary findings (Yin, 2009, p. 72). During the collection and analysis process I often encountered evidence that did not fit my presumptions. An illustration of this is that I based on my literature review on the petroleum industry expected that Cuba – by virtue of being a host state – should be better positioned in the bargaining with foreign oil companies than what was concluded to be the case. In this and similar situations I do believe

that I have been able to remain open. In addition, the repeated changes in research design can be seen as an indicator of this.

Nevertheless, according to Ragin & Amoroso (2011) elimination of selection bias cannot be achieved by the researcher himself. Only through peer reviews and responses by other researchers, now and in the future can this type of bias be recognized fully (Ragin & Amoroso, 2011, p. 70). In accordance, I have tried to make this chapter as transparent as possible so that others can reflect on the methods and sources that I have selected to reach my findings. In addition, persons that were central to the research process, such as my supervisors have read and commented on all parts of the thesis.

Another type of bias that deserves an own section here is related to access and availability of evidence. As commented on, despite spending a lot of time and effort trying to collect evidence from different sources, I had in large part to rely on sources not stemming directly from Cubans involved in the day-to-day activities of the Cuban petroleum sector. The difficulties of access information was not limited to interview subjects, as access to web pages of central Cuban organizations were either denied throughout the research period (such as the Ministry of Basic Industry), very unstable (the Ministry of Foreign Trade and Investment), contained mainly superficial information combined with 'dead links' (the National Office of Mineral Resources), or simply did not exist (as in the case of Cupet).

Further, a certain share of the collected data was previous studies of Cuba's petroleum sector or Cuba's energy sector. Such studies are of course subject to the interpretations and biases of the author. Again, however, I sought to triangulate the data collected from these studies with other sources (Punch, 2005, p. 241; Yin, 2009, pp. 114–18), such as statistical data offered by the national statistical office in Cuba, as well as with reports provided by oil companies such as Sherritt. I also sought to encounter the relative lack of accessible data by making changes in my research design, adjust my ambitions, and formulate new questions that could be answered based on the data that was possible to collect.

As for the documents and archival records that I collected while on my field trip in Cuba or gathered from Cuban web pages, I was guided by the evaluation of Plahte (2010): "Generally, Cuban sources should be regarded as quite reliable. […] Any manipulation of information by the government seems to take place by selection of released facts, rather than by distortion and fabrication of data." (Plahte, 2010, p. 69).

As stated, I also spent a lot of time assessing the trustworthiness of key informants by discussing their *bona fides* with other persons central in this thesis project, and by evaluating their works and citations in renowned publications. Finally, when I had to rely on

documentary data in the form of previous formal studies, I checked their number of citations in other research to access their impact and trustworthiness where this was available.

All in all, by being part of a larger and established research project, where I was given the opportunity to use the project framework, network, local contacts and partners, I feel that the validity of the work has been considerably enhanced. This made it possible for me to check the trustworthiness of key informants and sources with persons central in the thesis project, obtain a clearer contextualized understanding of Cuba, while being able to discuss my interpretations and findings with experienced researchers from various fields.

4.6 ETHICAL CONSIDERATIONS

As social research involves collecting data from and about people it also involves ethical considerations (Punch, 2005, p. 276). Ethical considerations are institutionally regulated in a number of ways. Some ethical considerations are clear from the outset, such as the deliberate publish of made-up data, plagiarizing, the deliberate mistreatment of research participants, and concealment (Ragin & Amoroso, 2011, p. 81). Other principles, such as safeguarding the privacy and confidentiality of the subjects, their informed consent, and avoiding their harm might, however, be less clear-cut in social contexts. As such, although important, ethical rules and committees have been criticized as being too rigid, and incompatible with the variable and unpredictable nature of social research (Dowling, 2010, p. 30; Ragin & Amoroso, 2011, p. 95). As such ethical considerations are often left to be worked out by the researcher throughout the research process (Ragin & Amoroso, 2011, p. 91).

The notion of critical reflexivity – a process of constant, self-conscious scrutiny of the self as researcher and of the research process – is a crucial conduct in this regard (Dowling, 2010, p. 31), and has been an important demeanor of mine throughout the research process. I have also done my utmost to respect the persons involved in this research by seeking to obtain the informed consent of the interview participants, offering anonymity, citation-checks and the right to deny tape recording if desired. The interview guide was attached to every request I sent to possible participants, which in addition to the aforementioned offerings informed about the purpose and future availability of the research.

5. EMPIRICAL FINDINGS AND ANALYSIS

5.1 HISTORICAL BACKDROP

As was discussed in section 3.1.1 and 3.2.2 in the context chapter, Cuba has for long periods been dependent on large, cheap, and stable supplies of petroleum from abroad. This has been crucial for both the energy security and overall welfare of the island state. Two highly advantageous trade agreements stand out in this regard.

First, with the trade of Cuban sugar in exchange with cheap crude oil from the Soviet Union, which lasted until the collapse of the latter. Second, through the barter agreement signed in October 2000 with Venezuela, which is still in place. Here, Cuban healthcare and other services are exchanged with Venezuelan crude oil and petroleum products. To date, the barter agreement with Venezuela provides Cuba with the almost all of its petroleum imports, estimated to be in the range of 100,000 bbl/d (J. Piñón, personal communication, February 15, 2013).

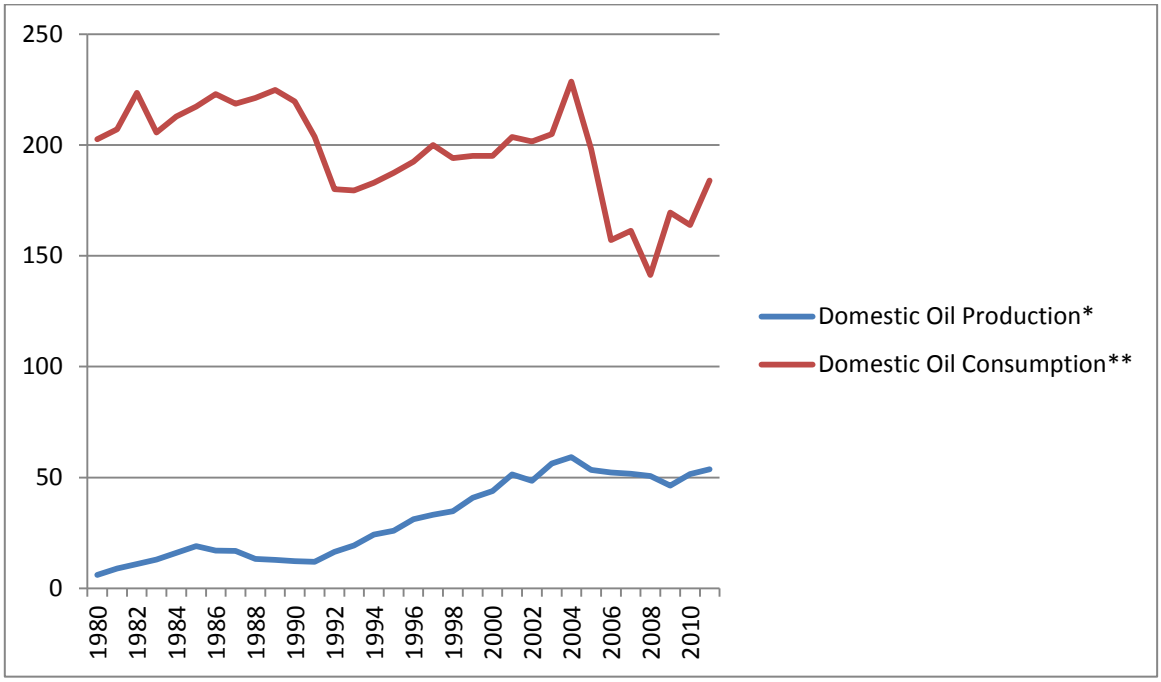
In between the two beneficial agreements, and illustrating Cuba's dependence on foreign beneficiaries, was a period of economic crisis where Cuba's energy consumption was sharply reduced and rationalized. Frequent blackouts caused by the lack of supplies to the heavily petroleum dependent electricity grid caused civil unrest. In this period, Cuba's petroleum sector was opened for foreign participation to increase domestic petroleum production.

Although the trade agreements with the Soviet Union and Venezuela have been essential for Cuba's energy security and economic welfare, the country also has a long history of small-scale domestic petroleum production. Scattered around the country are numerous surface manifestations of oil, and in the decades before the revolution a number of exploration wells were drilled in the area surrounding Jatibonico in the central parts of Cuba, as well as in areas close to the north coast of Havana (Amaro & Tenreyro, 2007). The discovered fields were small, however, and yielded no more than a total 600 – 800 bbl/d at the eve of the revolution in 1959. After the nationalization of the petroleum industry, exploration efforts were continued, building on documents and maps made by U.S. companies, which had previously owned and operated the industry. To organize the efforts, Cuba established an own petroleum institute in 1961, the *Instituto Cubano del Petróleo* (ONRM, 2013a).

During the 1960s, exploratory efforts yielded meager results. In fact, it was not until an agreement was signed with the Soviet Union in the exploration and production of oil that major fields were discovered, starting with the Varadero oil field in 1971 – Cuba's largest to

date (Benjamin-Alvarado, 2010). Throughout the 1970s- and 1980s domestic production levels picked up. In 1986 the levels were 3.3 times higher than in 1978, and 12 times higher than in 1956 (Castellón, 2004).

Nevertheless, from 1988 on, production levels decreased, caused among others by increased shortages of equipment and instruments, specialized technical resources, and delays in investment programs as the relationship with the Soviet Union began to deteriorate. In 1991 domestic oil production was no more than 11,671 bbl/d, and vastly exceeded by the corresponding consumption; 203,670 bbl/d (Figure 5.1). In relation, a cash-strapped Cuba opened its petroleum sector for foreign participation in 1993, with the goal to reduce imports and increase domestic production levels.



* Total oil production: production of crude oil (including lease condensate), natural gas plant liquids, and other liquids, and refinery processing gain (loss).
** Consumption of petroleum products and direct combustion of crude oil
Figure 5.1: Cuba's domestic production and consumption of oil, 1980-2011, bbl/d (Based on data from EIA, 2012b).[11]

5.2 THE BASIS OF CUBA'S RELATIVE BARGAINING POWER

In the following sections I present the basis of Cuba's relative bargaining power versus foreign oil companies. As stated in section 2.3 and 2.5 of the theoretical chapter, the relative

[11] Due to the long time scale, the numbers here are retrieved from the U.S. Energy Information Administration (EIA). Corresponding and retrievable numbers from the *Oficina Nacional de Estadísticas de Cuba* that are publicly available on the web only covers the years 1990, 1995, 2000-2011 (Oficina Nacional de Estadísticas de Cuba, 2011).

bargaining power of a host state is theorized to be an important determinant in the distribution of economic rents *and* for accessing inward transfers. Accessing technology and knowledge from foreign oil companies investing in its petroleum sector is of particular importance for Cuba, given its lack of access to multinational financing sources, and limited access to bilateral credit.

Most of the analysis considers Cuba's basic entry factors, arguing that the attractiveness of Cuba's petroleum resources is the most imperative factor for Cuba's bargaining power at this stage of the sector's development.

5.2.1 Basic Entry Factors

The bargaining power model (see section 2.3) proclaims that host states need to hold a sufficient amount of attractive resources to enter and negotiate in bargaining processes with foreign oil companies. Petroleum resources vary in terms of reserve size, longevity, and profitability.

Cuba's oil and gas discoveries to date have mainly been found in small and medium-sized fractured carbonate reservoirs in the North Cuba Fold and Thrust Belt, along a 200-by-15-kilometer stretch off the northern coastal and onshore region between Havana and Corralillo, North-East of Montebo (Figure 5.2). Due to their high levels of complexity and heterogeneity, recovering petroleum from these types of reservoirs is considered to be very challenging (Schlumberger, 2008).

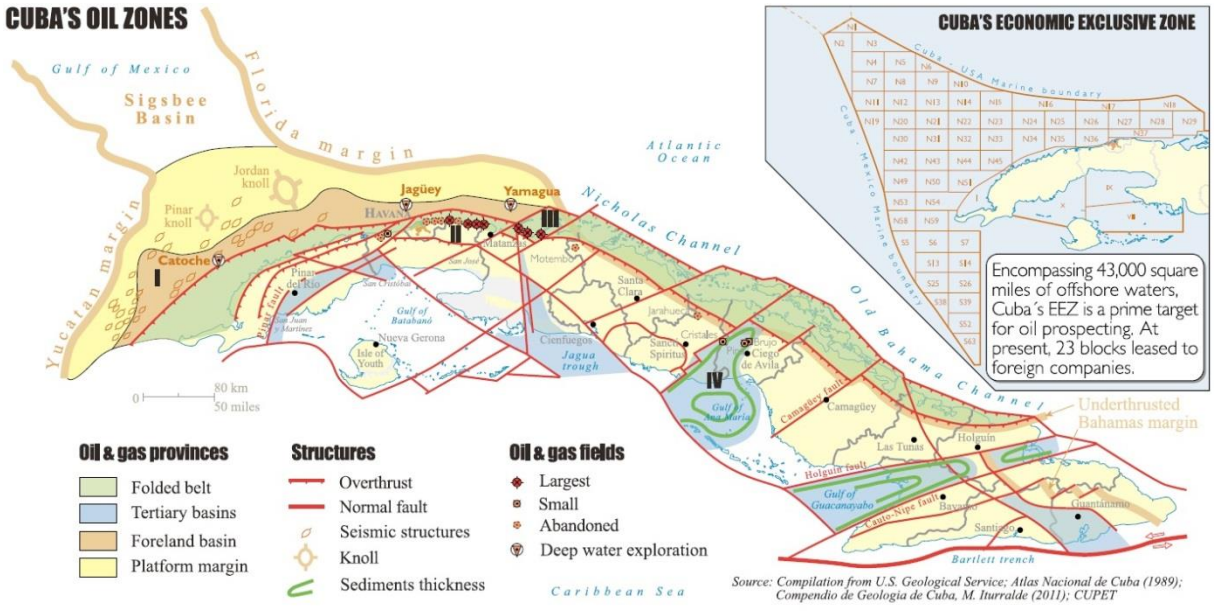


Figure 5.2: Cuba's oil zones with oil and gas fields (Presented in Portela, 2012).

Cuba does not publish data on petroleum reserves, but the country's proved crude oil reserves are estimated by the U.S. Energy Information Administration (EIA) to be at 120 million barrels, ranking the island state with the 62nd largest proved oil reserves worldwide (Table 5.1). Cuba's proved natural gas reserves are estimated to be 2.5 trillion cubic feet (tcf), the 54th largest in the world (Table 5.2). Most of the oil from the main oil fields is 9 to 12 degree API gravity heavy crude oil with a large content of sulfur and heavy metals.

2011 Proved Crude Oil Reserves by Country (billion barrels)	
>200	**Saudi Arabia** (262.6); **Venezuela** (211.2)
100-200	**Canada** (175.2); **Iran** (137.0); **Iraq** (115.0); **Kuwait** (104.0)
50-100	**United Arab Emirates** (97.8); **Russia** (60.0)
25-50	**Libya** (46.4); **Nigeria** (37.2); **Kazakhstan** (30.0); **Qatar** (25.4)
10-25	**United States** (23.3); **China** (20.4); **Brazil** (12.9); **Algeria** (12.2); **Mexico** (10.4)
<10	80 countries, including **Angola** (9.50); **Norway** (5.67); and **Cuba** (0.12)
0 (none)	117 countries

Table 5.1: List of countries by proved crude oil reserves, 2011, (Adopted from EIA 2013b).

2011 Proved Natural Gas Reserves by Country (trillion cubic feet)	
>1,000	**Russia** (1,680); **Iran** (1,046)
300-1000	**Qatar** (896); **United States** (305)
200-300	**Saudi Arabia** (296); **Turkmenistan** (265); **UAE** (228)
100-200	**Nigeria** (187); **Venezuela** (179); **Algeria** (159); **Iraq** (112); **Australia** (110); **Indonesia** (106)
50-100	**Kazakhstan** (85); **Malaysia** (83); **Egypt** (77); **Norway** (72); **Uzbekistan** (65); **Kuwait** (64); **Canada** (62); **Libya** (55)
10-50	Approx. 15 countries, including **Angola** (11)
1-10	Approx. 30 countries, including **Cuba** (2.5)

Table 5.2: List of countries by proved natural gas reserves, 2011, (Adopted from EIA, 2013c).

The combination of Cuba's reserve characteristics and heavy crude oil make extraction and processing a real challenge. As a consequence, current recovery rates are estimated to be at a low seven percent of proved reserves (Piñón & Benjamin-Alvarado, 2010). Further, the characteristics of the crude leave Cuba's refineries, largely equipped with Soviet technology, unable to process it. In consequence the domestic oil is largely burnt directly as crude for electricity consumption in Cuba's thermoelectric power plants (Nerurkar & Sullivan, 2011).

For these reasons, Cuban domestic crude is sold at a discount of common reference products and crude oils produced in other countries. According to the Canadian private oil firm Sherritt International (2011), which is the only foreign oil firm with petroleum production in Cuba today, the average realized sales price per barrel of oil produced in Cuba was US$ 68.47 in 2011, up from US$ 52.24 the year before. In comparison, the corresponding numbers for U.S. Gulf Coast Fuel Oil No. 6 – a refined product marketed along the U.S. Gulf Coast – were US$ 95.41 and US$ 69.76 respectively. The numbers for Brent crude oil – which is of higher quality than the Cuban crude – was US$ 112.14 and US$ 79.89 (Sherritt International Corporation, 2011).

Still, characteristics about heavy oil reservoirs, such as generally long field lives coupled with enhanced recovery technologies make heavy oil development more attractive today than in previous decades, at current world oil prices at some US$ 100 per barrel.

Cuba's onshore and coastal crude oil production reached its peak in 2003 and has stabilized around 50-55,000 bbl/d (including some natural gas liquids) in recent years. Its natural gas discoveries to date have been associated natural gas found within the crude oil reservoirs. The production of natural gas peaked in 2007 with some 20-21,000 barrels of oil equivalent a day (boe/d), and has decreased somewhat since. According to the EIA (2012b) "any additional increases in production [of crude oil and associated natural gas depends] upon the discovery of substantial new reserves" (EIA, 2012b). This statement is also supported by the Canadian oil company Sherritt International. In its fourth-quarter 2012 report the company states that its gross working-interest production in Cuba for 2013 is expected to be some 11 percent lower than in 2012 due to natural reservoir declines (Sherritt International Corporation, 2012a). This is also in line with trends from the past few years (Sherritt International Corporation, 2011).

Apart from Sherritt's concession to block number 7 (Figure 5.3), another four foreign companies held a total of 10 onshore and coastal blocks in Cuba as of 2009 (Piñón & Benjamin-Alvarado, 2010). Among these, only preliminary seismic work has been conducted. The exception to this is Russia's Zarubezhneft, which currently conducts exploratory drilling in the deep shelf oilfields off Cayo Coco (coastal block L, Figure 5.3). Zarubezhneft also holds concessions in block 9 (onshore), and block III (in the offshore transition zone). The drilling in block L began in late 2012, with the results expected to be presented in mid-2013. The total investment levels of Zarubezhneft's drilling are estimated to be at US$ 126 million (Cuba Standard, 2012; Zarubezhneft, 2011).

It is the deep offshore blocks in the Gulf of Mexico that seems to be the most promising area for substantial petroleum reserves. The area lies in the same geological strata as the petroleum-rich Mexican and U.S. Gulf. Here, Cuba's Exclusive Economic Zone (EEZ) covers a 19,000 km^2 area with an average ocean depth at approximately 2000 meters (Figure 5.4). A U.S. Geological Survey report estimates a mean 4.6 billion barrels of undiscovered oil and a further 9.8 trillion cubic feet (tcf) of undiscovered natural gas along Cuba's North Belt Thrust (U.S. Geological Survey, 2008). According to the same report, the high-end potential of the same area is estimated to be 9.3 billion barrels of oil and 21.8 trillion cubic feet of natural gas.

If certified as recoverable, the undiscovered offshore reserves would rank Cuba among major Latin American petroleum producers such as Colombia and Ecuador. The report contains the only hard geological data that publicly exists of Cuba's petroleum potential in its EEZ. However, the real potential might be even bigger when other parts of the EEZ are included (The Brookings Institution, 2010, p. 10). Cuba's own estimates of the whole area has been reported to be as high as 20 billion boe (Voss, 2011).

Operating at these depths is very expensive and carries high geological and technical risk. Industry experts anticipate that a crude oil price of more than US$ 65 per barrel must be in place before any deepwater projects would be financially worthwhile (Simpkins, 2013). The Cuba North Coast Deepwater project would take from two to three years to bring into full development, with an estimated total cost of US$ 1 billion to US$ 3 billion (Piñón & Benjamin-Alvarado, 2010).

Despite the uncertainties and high-cost prospects, however, *Unión Cuba-Petróleo* (Cupet) had by the end of 2009 cosigned 21 of the 59 deep-water blocks in the EEZ, with nine more completed by mid-2011. Since 2009 crude oil prices have grown significantly, and are today in excess of US$ 90 a barrel (see Appendix 2), making deepwater projects potentially very profitable.

Exploratory drilling so far has been sobering, however. In 2004 Repsol YPF from Spain drilled the first exploratory well within the EEZ. The well confirmed a system of high-quality crude oil, but was considered noncommercial (Reuters, 2008). During 2012 three additional wells were drilled, using the semi-submersible rig Scarabeo 9[12]: first by Repsol in consortium with Norway's Statoil and a unit of India's ONGC in May; then by a subsidiary of Malaysia's Petronas and Gazpromneft of Russia in July; and lastly by PDVSA of Venezuela

[12] The rig contains less than 10 percent U.S. components, thereby avoiding the triggering of U.S. sanctions.

in October. Of these three it was reported that the second well hit an active petroleum system but that the discovery was not commercially viable (Orsi, 2012b). The first and third well came up dry (Orsi, 2012a, 2012c).

In the aftermaths of the dry well both Repsol (Repsol's Chairman Antonio Brufau to BBC News, 2012) and Statoil left Cuban waters. ONGC still holds two independent blocks, and is currently searching for partners to share the high costs (Franks, 2012a). In 2011 Petrobras also decided to withdraw from its block due to discouraging seismic results, and a wish to concentrate more exclusively on Brazilian reserves (Frank, 2011). Other companies with block concessions seem either incapable of being operator of such deepwater projects, or have dubious financial resources (Piñón & Benjamin-Alvarado, 2010).

5.2.2 International Context

As noted in section 3.2.1 in the context chapter, the international context has generally favored the relative bargaining power of host states since the turn of the millennium. This was also in place on the initial stages of domestic petroleum sector development in Norway and Angola, arguably strengthening the relative bargaining position of these countries.

Over the past 10-15 years increased industry competition has left host states in a better position to play foreign oil companies against each other, and the high oil prices have left host states less dependent on foreign participation to increase efficiency. Further, the perceived scarcity of petroleum resources, combined with a resurgent resource nationalism, and a high concentration of remaining resources have all favored the relative bargaining position of the host states (Vivoda, 2011).

A by-product of the international developments during the past 10-15 years has been that oil companies, both private and public, have increased their efforts to search for and produce hydrocarbons in peripheral areas, such as in heavy crude oil onshore reservoirs or deepwater areas. As such, an estimated total of US$ 2 billion have been spent in Cuba's upstream oil and gas sector between 1991 and 2010 (Piñón & Benjamin-Alvarado, 2010). Further, a reported US$ 700 million have been spent in exploratory works offshore Cuba during the past decade (Gibson, 2013). In addition, one of the oil companies that drilled an exploratory well in the EEZ was the national oil company of Cuba's close political and strategic ally, PDVSA of Venezuela. At a first glance, then, one might expect that the international context is very favorable for Cuba indeed.

As pointed out in the section above, however, large sunk cost in exploration efforts and an otherwise favorable international context did not prevent leading oil companies like Repsol, Statoil, or Petrobras from leaving Cuba when oil was not discovered. Further, the strategic relationship Cuba enjoys with Venezuela is severely restricted in at least one crucial point. As with the Cuban petroleum sector, the Venezuelan industry is exclusively onshore-based. Thus PDVSA has very limited offshore experience. In fact, the exploratory well it drilled off Cuba last year was the first offshore well ever drilled by the Venezuelan company. In the foreseeable future then, with the disappointing results from 2012, no exploratory wells will be conducted in Cuba's EEZ, neither by PDVSA nor by any other foreign oil companies (J. Piñón, personal communication, February 15, 2013).

To sum up, although Cuba by virtue of being a host state enjoys a favorable international context, this seems to have been limited to making Cuba's prospected offshore resources attractive enough to explore for oil. It did not, however, prevent leading oil companies to leave when the prospects decreased during 2011 and 2012.

5.2.3 Host Country Context

If the current international context favors host states, and to a point also Cuba in that it has made exploratory drilling in its EEZ more attractive, domestic factors in Cuba generally seem to disfavor Cuban relative bargaining power. There are a number of reasons for this interpretation.

First, the model predicts that if the petroleum sector is of high strategic importance for the host country, foreign oil companies are expected to find themselves in a relatively weak bargaining position because the host state is more prone to intervention. As will be further discussed in section 5.3, the petroleum sector is one of Cuba's prioritized sectors, with the country depending on liquid fuels for 85 percent of its power production – the bulk of which is secured through the favorable agreement with Venezuela (Belt, 2010).[13] To achieve the goal of increased domestic production (Sixth Congress of the Communist Party of Cuba, 2011), Cuba depends heavily on the resources of foreign oil companies, particularly offshore. For Cuba then, the strategic importance of the sector does not seem to increase its relative bargaining power. Rather, Cuba depends on attracting their participation in order to achieve the goals that made the sector strategic in the first place: energy security, and economic and social welfare.

[13] According to British Petroleum statistical review from 2012 oil and other liquids remains the leading fuel with 33.1 percent of global energy consumption, with natural gas at 23 percent (British Petroleum, 2012).

Further, the model predicts that the level of economic development of a country is expected to reflect its level of absorptive capacity (Vivoda, 2011). If a country possesses actors with high levels of absorptive capacity, it is expected to be better suited to recognize new information, assimilate it, and apply it for commercial ends. This is thought to increase the relative bargaining power of the country. While Cuba is a developing country, the country has long emphasized the role of competence in scientific and technological fields for economic growth and social welfare. As such, it is commonly noted that Cuba scores relatively well on most indicators of human capital (Brundenius & Göransson, 2011; Brundenius, 2009; Domínguez, 2012; Jover, Arriete, Ones, González, & Cuavas, 2011).

The expectation that host states are in a better bargaining position due to their ability to recognize, assimilate, and apply new information for commercial ends is of course the idea that is expanded on through the circular causality model proposed in the theoretical chapter (Figure 2.5). As will be further discussed in section 5.4, actors in Cuba's petroleum sector seem to possess a significant degree of absorptive capacity. As stated, however, in upstream operations this is largely confined to onshore and/or coastal activities.

As such, it was in the onshore sector that the scrapping of the Canadian oil company Pebercan occurred. To my knowledge, this is the only published occurrence of such an incident in Cuba's petroleum sector. This was in 2009, when Cuban authorities, through Cupet, terminated the product sharing agreement it had cosigned with Sherritt's Montreal-based partner Pebercan Inc., nearly ten years before the contract's termination date (Feinberg, 2011; Havana Journal, 2009a). While the exact causes of the early termination have yet to be commented on by Pebercan or Cupet, it seems to have involved severe payment difficulties on the part of Cupet for the crude oil produced by Pebercan on Cuban soil.

By 2009, however, Pebercan had transferred all of its contractual operations to Sherritt, and was in practice relegated to the role of a silent financial partner in upstream operations on the island. In 2009 then, Cupet did not seem to be dependent on the unique resources of Pebercan as an oil company. To state that this was in fact due to the absorptive capacity of actors in the Cuban petroleum industry is, however, stretching it far. The operations of Pebercan were transferred to Sherritt, another foreign oil company, and not to Cupet.

Further, the political and cultural context of host states, including its attitude towards foreign participation are expected to mediate bargaining power. The ambiguity of Cuban authorities towards FDI are well-documented (Feinberg, 2012; Villanueva, 2012). On the one hand Cuba offers a fair amount of incentives through its foreign investment law. In the

petroleum industry this is also expressed through a commercially very favorable product sharing agreement offered to foreign participants. On the other hand, the top national leadership was long very suspicious towards foreign capital, and orthodox factions in both the government and Communist Party have revealed their enduring distrust in the *Guidelines* (Feinberg, 2012). Foreign actors in the petroleum sector have not been sheltered from this, as illustrated by the Pebercan incident.[14]

In relation, the country has received less favorable risk assessments from various strands. According to Coface (2013), Cuba scores unfavorable both in terms of risk assessment and business climate assessment. Of the factors contributing to the high risk environment is Cuba's economic dependence on Venezuela, its limited access to foreign finances, and the U.S. embargo (Coface, 2013). The Economist Intelligence Unit characterizes the investment climate in Cuba somewhat more favorable, but categorizes it among countries with a questionable capacity and commitment to honor obligations, and a patchy payment record (EIU, 2013).

Of the foreign oil companies with the most substantial involvement in Cuba today, Sherritt and Zarubezhneft, both acknowledge risks related to their Cuban investments. Sherritt (2011) lists risks such as fluctuations in official or convertible exchange rates and high inflation rates; changes in political attitudes toward foreign investments; environmental risks represented by hurricanes and tropical storms; and the possible inability of the Cuban government to fulfill its payment obligations to the company (Sherritt International Corporation, 2011). Zarubezhneft (2011) adds that the absence of an independent court system, and limitations on business and private property contribute to the high risks associated with conducting business in Cuba (Zarubezhneft, 2011). Again, the Pebercan case is illustrative, showing that "when the Cuban state falls seriously into debt with an international partner, it may choose to close it down and wrap the arrears into a broader deal liquidating all assets." (Feinberg, 2012, p. 34).

To what degree the risky business climate have made the Cuban petroleum sector less attractive for foreign oil companies, and thus reduced Cuba's relative bargaining power, is difficult to assess due to the general lack of accessible data on the subject. It did not, however, discourage a broad range of foreign oil companies to bid for concessions and conduct

[14] Although Sherritt have also experienced payment delays, it received US$74.1 million of the US$ 140 million that Pebercan received in the settlement, "as its share of the proceeds in respect of its interests in Block 7." (Sherritt International Corporation, 2012b). The Pebercan incident has not deterred Sherritt from further investing in Cuba's petroleum sector, however. In 2011 the company completed seven development wells, and prepared applications for additional blocks for future exploration (Sherritt International Corporation, 2011).

exploratory activities in Cuba's EEZ when the prospects for significant petroleum discoveries were perceived to be high.

Other host state contextual factors seem less ambiguous, however. In terms of host country size and size of local markets (both of which are predicted to increase host state relative bargaining power if they are large), none of these benefits Cuba. With a population of some 11 million producing a nominal GDP of US$ 68.715 billion, the per capita GDP is at US$ 6,106, ranking the country as number 88 of 195 countries according to the United Nations (United Nations Statistics Division, 2013). The dire economic situation – amplified by severe difficulties in accessing external finances – makes Cuba very dependent on attracting FDI (Villanueva, 2012). All of this suggests a lower relative bargaining power for Cuba.

To sum up, contextual factors associated with Cuba as a host state, although difficult to firmly assess, seem generally much less favorable than the international factors described above. Cuba is very dependent on the resources of foreign oil companies, particularly in offshore operations. The spurring of domestic petroleum production is especially important in Cuba, where the petroleum and power sector are highly interlinked. The ambiguous attitude towards FDI and a risky investment climate are also suggested to reduce Cuba's relative bargaining power, although in Cuba's case the risks were not so high as to have prevented significant levels of interest and investment.

5.2.4 The U.S. Embargo

One factor that does not readily fit the bargaining power framework is the risk represented by the U.S embargo (see section 3.1.4). This puts Cuba in a special position compared with other countries. Again, Sherritt (2011) notes that the U.S. embargo represents a significant risk, and that "the threat of potential litigation discourages some potential investors, lenders, suppliers and customers from doing business with Sherritt." (Sherritt International Corporation, 2011, p. 60). Further Zarubezhneft (2011) states that

> [t]he most considerable risk for the company's projects in the Republic of Cuba is the existing economic blockade on the part of the USA that negatively affects the cost and project implementation periods. Finally, it may have a negative effect on total profitability and the period of the projects' implementation in the Republic of Cuba. (Zarubezhneft, 2011, p. 28).

As for the exploration efforts in Cuba's EEZ, the combination of deep depths and the U.S. embargo made exploratory drilling especially challenging. Currently, only the Scarabeo drill-rig, which was leased during 2012, is able to drill at these depths without provoking U.S.

sanctions. According to Jorge R. Piñón, the challenges posed by the U.S. embargo contributed to making the exploratory drillings of 2012 on average 15-18 percent more expensive than comparable operations in the US Gulf Coast (J. Piñón, personal communication, February 15, 2013). Further, by denying companies with engagement in Cuba to access the highly competitive U.S. oil service and equipment market, as well as its huge consumer market, any oil company with petroleum discoveries in Cuba will have a hard time monetizing it (Piñón & Benjamin-Alvarado, 2010).

Again, however, Cuba's possible petroleum resources in the EEZ were perceived to be attractive enough to invest a substantial amount of time and costs to hire the Scarabeo 9 to avoid triggering U.S. sanctions, from a broad range of major foreign oil companies. Whether further exploratory efforts would have been conducted without the U.S. embargo, both offshore and onshore is difficult to assess due to the lack of data. Nevertheless, U.S. companies, which have expressed wishes to invest in Cuba (Gorman, 2004), are closed off.

5.2.5 Summary: Cuba's Relative Bargaining Power

The rationale behind assessing the basis of Cuba's relative bargaining power is that it was theorized as a prerequisite for accessing foreign petroleum industry knowledge and technology. As such, this section has sought to identify opportunities and barriers for Cuba in accessing these assets.

Cuba's basic entry conditions – its proved and possible petroleum resources – have attracted a number of foreign oil companies to sign concessions, both for onshore, coastal, and offshore blocks. Its proved resources are small compared with most petroleum countries, however, and production to date has stemmed from onshore or coastal fractured carbonate reservoirs, containing mostly heavy and sulfur-rich crude. By and large, Cuba's proved reservoirs are small in an international context, and in natural decline.

Cuba's greatest potential of substantially adding to its petroleum resources lies underneath the seabed of the deepwater areas of its EEZ. If the estimated reserves located here are certified as recoverable, it would rank Cuba among major Latin American producers; while lowering its dependence on subsidized petroleum imports. Exploratory drilling so far has failed to provide commercial discoveries, however, and judging by the pull-out by major companies such as Repsol, Petrobras, and Statoil the commercial interest of the area has decreased significantly during the last few years. As a result, exploratory drilling in the area is currently postponed indefinitely.

Presently then, (if one is to attribute all foreign activity exclusively to the resources of a country, while ignoring factors such as investment risk), Cuba's petroleum resources attract considerable investments in upstream operations from only two companies. Of those only Canada's Sherritt is producing oil and gas, while Russia's Zarubezhneft conducts exploratory drilling in coastal waters. Offshore, where Cuba has the highest probability of being in a relatively strong potential bargaining position, actual bargaining agreements have failed to manifest whatsoever. The overall attractiveness of Cuba's basic entry conditions, then, are perceived as low compared to those of most other petroleum producing countries.

In consequence, one might suggest that international and host country contextual factors do not seem to play any substantial role for the relative bargaining power of Cuba, simply because – disregarding the small-scale onshore and coastal resources – there is not much to be bargaining about. As shown in the context chapter, the prerequisite for inward transfers in Norway and Angola was of course that prospects of substantial petroleum resources were in place, and subsequently discovered.

While this might be true, international and host country factors were also crucial for the successful facilitation of inward transfers in those countries. At the initial stages, both countries benefitted from a favorable international context resembling many aspects of the situation today. Domestically, both countries – although differing substantially on most indicators – managed to offer what was perceived to be a sufficient investment climate in the eyes of the foreign oil companies.[15]

For Cuba as well, international and host country factors will be crucial for the future prospects of the petroleum sector when and if additional discoveries are made. In addition, although the onshore- and coastal resources are small compared to those of most petroleum-endowed nations, in the small and developing country-context of Cuba they provide substantial possibilities in many respects: for increasing profits and energy security; for accessing foreign technology and knowledge; and for building capabilities if petroleum is found in larger quantities in the future.

As such, although Cuba's petroleum reserves today are limited, the only offshore area that has been explored to some extent is along the North Belt Thrust close to the mainland. Further, at least two of the four exploratory wells that were drilled in Cuba's EEZ were not dry, but characterized as 'non-commercial'. In comparison, as stated in section 3.3.3 of the

[15] While not as sincere as the risks associated with investing in Angola, risk was also a concern for foreign oil companies investing in Norway in the late 1960s. Here, risk was connected to the perceived socialism of the Norwegian government (Ryggvik, 2010, p. 71).

context chapter, it took a total of 32 exploratory wells before any major fields were discovered off the coast of Norway. As expressed by Jorge R. Piñón: "I'm still optimistic that Cuba will be able to find commercial oil reservoirs offshore. How much, how big, that I think is too early." (J. Piñón, personal communication, February 15, 2013).

Stating it differently, there are still possibilities for major petroleum discoveries in the future, and with that; for accessing the industry know-how and technology held by foreign oil companies. In the international context, factors such as increased industry competition, exceptionally high oil prices, a perception of petroleum scarcity, and a high degree of resource nationalism and resource concentration have contributed to this. As a result, peripheral areas such as the deepwater areas of Cuba's EEZ have become more attractive in the eyes of most oil companies. As such Cuba *has* seen considerable levels of FDI spent in its offshore oil and gas sector during the past two decades. Again, however, the favorable international environment did not prevent major oil companies to pull out from Cuba when the exploratory work failed to produce commercial discoveries. For Cuba then, one might say that the favorable international context rendered its basic entry conditions more attractive, making exploratory drilling possible, but that this was of little significance when petroleum was not discovered.

If future discoveries are to be utilized, however, host country contextual factors should also favor Cuba's relative bargaining power. As suggested by the empirical analysis; in general, this does not seem to be the case. While the strategic importance of the petroleum sector is high, the sector has depended heavily on the resources of foreign oil companies to increase production, and will continue to do so in the future. This will particularly be the case for upstream operations offshore, where Cuban actors have little experience, and requirements of capital, technological know-how, and managerial skills are much higher than in corresponding operations onshore.

Further, Cuba's size, the size of its domestic market, as well as its high dependence on FDI for the well-being of its economy all point to a disfavoring of Cuba's relative bargaining power. The same is suggested for the unfavorable risk assessments – which also involve the U.S. embargo – and the ambiguous policy of the Cuban authorities towards foreign investment and participation. Regarding the latter points, however, it was noted that these factors have not been so unfavorable as to preclude investments in the sector whatsoever.

From these considerations, it might be possible to reach an answer to the first sub-research question of this thesis:

What is the basis of Cuba's bargaining power versus foreign oil companies?

The empirical material suggest that, despite a favorable international context, Cuba's limited level of proved resources and the unsuccessful exploratory work done in its EEZ, paired with a high dependence on the resources of foreign oil companies and an otherwise unfavorable host country context, form a basis of *weak relative bargaining power for Cuba versus foreign oil companies*. This is particularly the case in offshore operations where, even though the resource potential is highest, commercial discoveries are yet to be proved, and Cuban capabilities are the most limited.

As will be further discussed in section 5.3.1, the weak relative bargaining power of Cuba seems to be reflected in the favorable product sharing agreement offered to foreign oil companies interested in investing in the petroleum sector of the island state. Nevertheless, as seen in the cases of Norway and Angola, a high dependence on the resources of foreign oil companies did *not* preclude the access to, and facilitation of substantial inward transfers and domestic capability building in the petroleum sectors of these countries.

Of course, the successful development of the petroleum sectors of these countries would not have been possible without the discovery of substantial amounts of petroleum resources. While Cuba's onshore and coastal reservoirs are in general decline, exploratory drilling in Cuba's EEZ is postponed indefinitely. Cuba's access to the knowledge and technology held by the foreign oil companies are limited by these facts. Still, substantial offshore reservoirs might be discovered in the future, which will leave Cuba in a better potential relative bargaining position. In addition, while existing onshore- and coastal reservoirs seem to be in general decline, the exploratory drilling currently made by Zarubezhneft off Cayo Coco might produce significant results.

As argued in section 2.5 of the theoretical chapter, whether and to what degree Cuba will be able to utilize these resources depends on its interest in, and ability to facilitate inward transfers to domestic actors, while simultaneously develop the abilities of these actors to assimilate and exploit the transfers. As shown in the cases of Norway and Angola, these considerations figured high on the petroleum technology policy agenda in both states, the result of which – increased domestic capabilities – have contributed greatly to increased relative bargaining power, inward transfers, and the acquisition of economic rent in these countries.

5.3 CUBA'S PETROLEUM TECHNOLOGY POLICY

In the following sections I map out the main components of Cuba's petroleum technology policy. As stated in section 2.5 of the theory chapter, the technology policies of a host state plays a crucial role for the nature and facilitation of inward transfers. Two aspects are highlighted in this regard: *(i*) Cuba's policy towards foreign participation in the sector since the beginning of the 1990s; and (*ii*) whether there exists a policy of domestic capability building through inward transfers and domestic support.

5.3.1 Outward Orientation

After the abrupt ending of bilateral relations in the beginning of the 1990s, Cuba reexamined its policy towards foreign investments in order to increase the role of FDI in its economy. As noted, attempting to attract FDI made sense because Cuba lacked access to multinational financing sources, and had only very limited access to bilateral credit due to its foreign debt (Villanueva, 2012). In consequence, Cuba established the *Escuela Cubana de Negocios* in 1992. The rationale behind the establishment was outlined in three general principles: (*i*) to offer legal guarantees to foreign partners that took the risk of investing in the country; (*ii*) to conquer new international markets; and (*iii*) to develop and access new technologies from abroad (Cuban petroleum industry source). By accessing new markets, capital, and technology Cuba was to embark on the development path and reduce the gap to frontier countries.

At the national level the outward orientation was institutionalized with Law 77 of 1995 and Resolution 5290 of the Executive Committee of the Council of Ministers, both still in effect (MINCEX, 2013; Villanueva, 2012). In relation, the petroleum sector was early on targeted and opened up for foreign investment. A total of 33 onshore and coastal blocks were opened for bidding in 1993, followed by 59 offshore blocks in the Gulf of Mexico Economic Zone in 1999 (Figure 5.3 and 5.4).

Attracting FDI into the petroleum sector has continued to figure high on the Cuban political agenda. In a 2012 list of portfolio projects available for foreign investment issued by the *Ministerio del Comercio Exterior y la Inversión Extranjera* (MINCEX), onshore and offshore projects in the petroleum industry are included and emphasized (MINCEX, 2012). In particular, projects to explore for petroleum in the Gulf of Mexico Economic Zone have been of special importance (Villanueva, 2012). Further, U.S. participation has been explicitly welcomed on a number of occasions (Hernanez Perez, cited in Wayow, 2011).

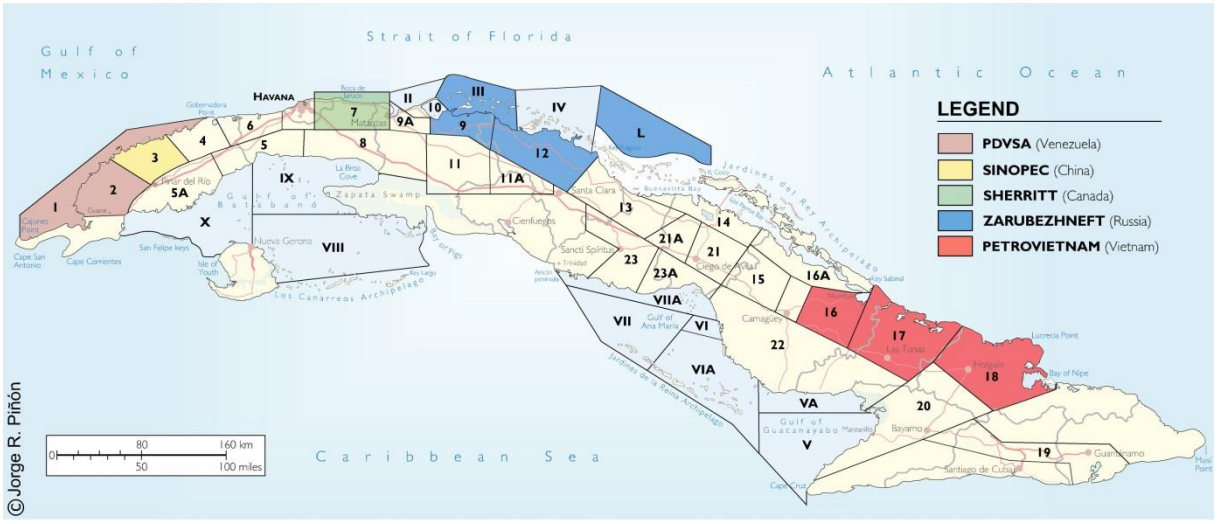


Figure 5.3: Cuba's onshore and coastal blocks with concessions of foreign oil companies as of 2010, (Cuba Standard, 2010, map courtesy Jorge R. Piñón).

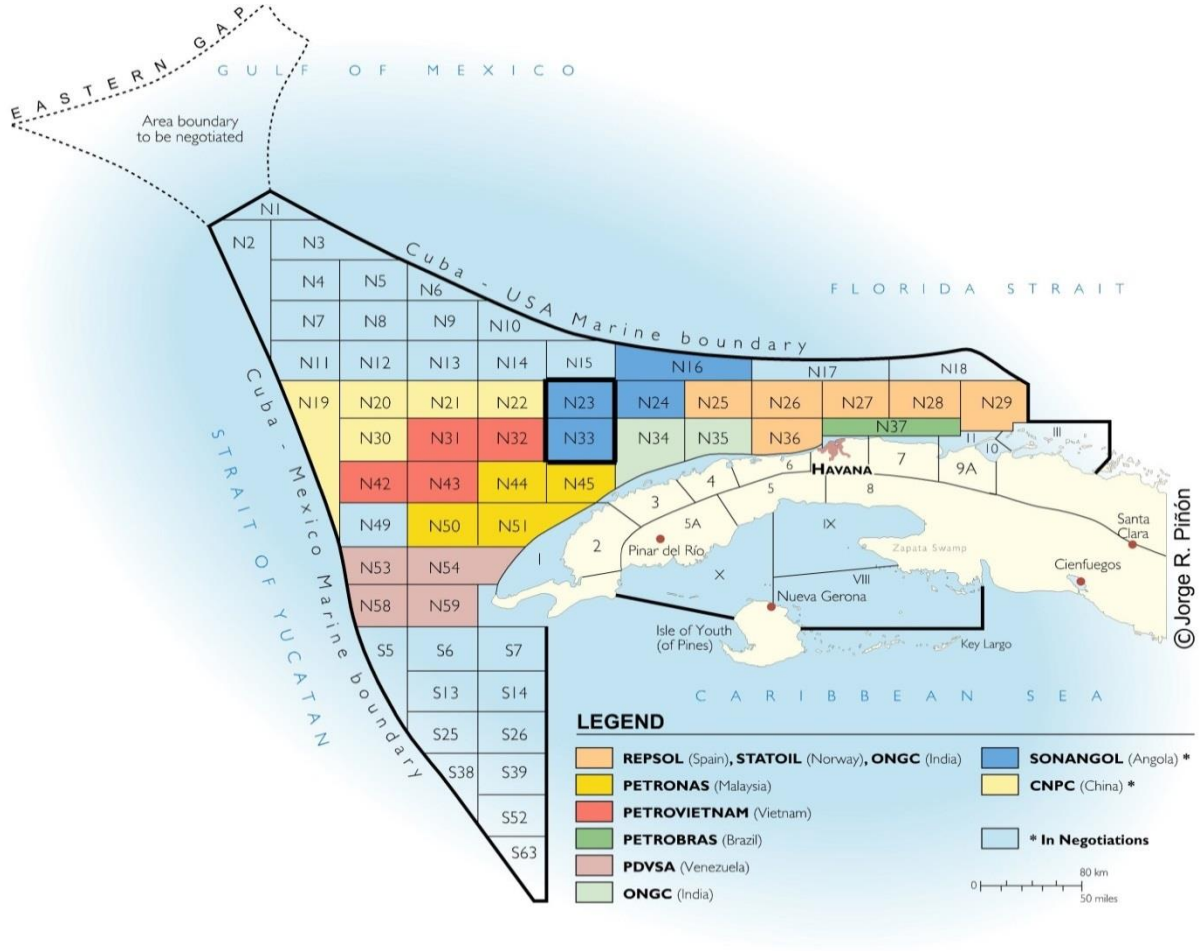


Figure 5.4: Cuba's offshore blocks with concessions of foreign oil companies as of 2010, (Cuba Standard, 2010, map courtesy Jorge R. Piñón).

All of Cuba's blocks are offered for bidding to foreign oil companies through a so-called product sharing agreement (PSA, see Appendix 1), which is a common contractual agreement

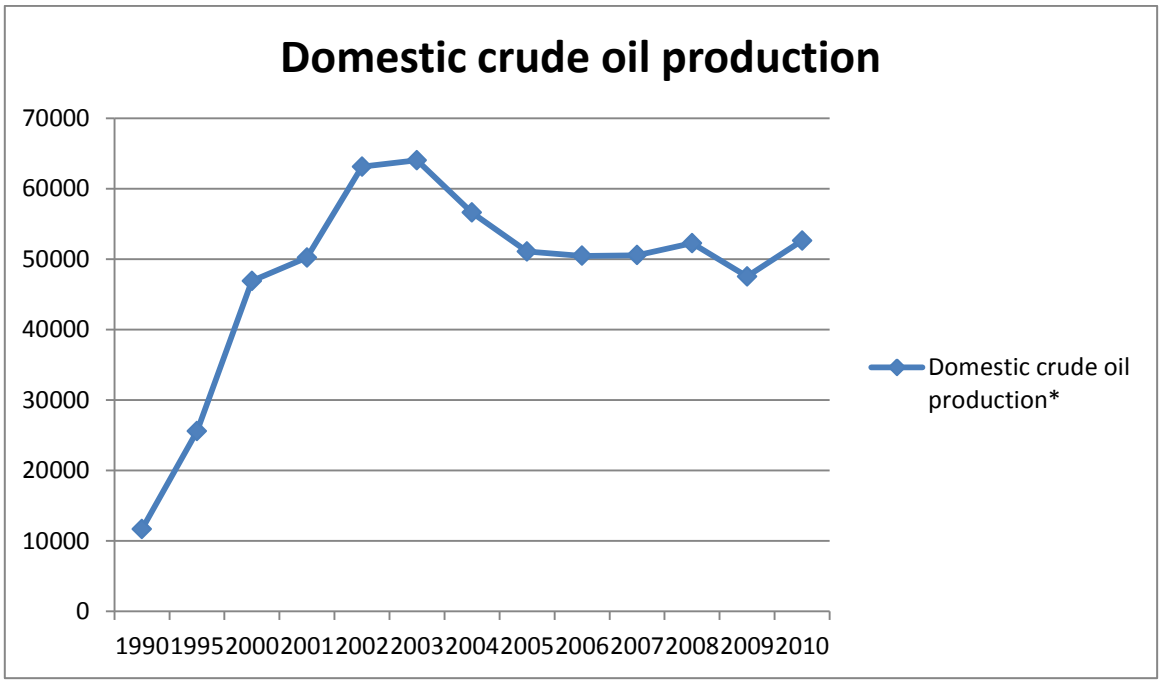
accepted by most oil companies in the petroleum industry today. Under its PSA, Cupet awards the rights to a third-party contractor to explore for and produce hydrocarbons within one of the blocks for a given period of time. The third-party contractor is the joint venture enterprise established between the Cuban government entity and the foreign oil company, and is responsible for supplying all capital, equipment, installations, technology, and personnel required to carry out the operations as outlined in the contract (Piñón & Benjamin-Alvarado, 2010).

According to the MINCEX (2012) Cuba requests investments in the range of US$ 15 and US$ 20 million in onshore and coastal blocks from foreign contractors. The corresponding requests in offshore blocks are between US$ 160 and US$ 180 million (MINCEX, 2012). The large upfront investments can be recovered through so-called cost oil (see Appendix 1), however, if oil or gas is found in commercially viable quantities. Once costs have been recovered, the remaining oil – or 'profit oil' (see Appendix 1) – is divided between Cupet and the foreign contractor in agreed proportions as outlined in the PSA. In the case of Sherritt this amounts to 45 percent of the remaining production once costs have been recovered (see table 5.3). The contractor's share of oil production can be exported in kind or sold to Cupet according to an agreed-upon price formula. In the case of Sherritt: "All of Sherritt's oil sales in Cuba in 2011 were to an agency of the Government of Cuba." and "The pricing for oil produced by Sherritt in Cuba is based on Gulf Coast Number 6 reference prices." (Sherritt International Corporation, 2011, p. 27).

As for the associated natural gas, the foreign partner does not receive any allocation of the production, but is entitled to recover all production costs. Further, the contractor generally pays taxes of 25 percent of personnel salaries and 30 percent on net profits to the Cuban government (Piñón & Benjamin-Alvarado, 2010). The PSA that Cuba offers provides the foreign investor with attractive terms and is characterized as commercially very favorable (Belt, 2010; J. Piñón, personal communication, February 15, 2013.[16] Overall the institutional framework surrounding foreign participation in Cuba's petroleum sector can be characterized as favorable for the foreign partner, an interpretation supported by the Russian oil company Zarubezhneft (2011) stating that "Cuban law "On foreign investments" gives foreign investors the opportunity to receive significant benefits." (Zarubezhneft, 2011).

[16] The PSA that Cuba is offering has in fact been characterized as "much more commercial than the one from Venezuela or other countries". (Piñón, personal communication, February 15, 2103). For a comparison with other countries, see Appendix 5).

Judging by its formal institutional framework, then, Cuba has carried out a high degree of openness in its oil sector since 1993. As stated in section 5.2.2 estimates from 2010 suggest that Cuba has seen close to US$ 2 billion of foreign investment spent in its upstream oil and natural gas sector alone (Piñón & Benjamin-Alvarado, 2010), contributing to a seven-fold increase in domestic production (Figure 5.5 and 5.6).



* Including diluents.[17] Numbers reported by the ONE is given in metric tons, and a weighted average conversion factor of 6.35 barrels per ton has been selected here.
Figure 5.5: Cuba's crude oil production, 1990, 1995, 2000-2010, bbl/d (Author compilation, based on data from Oficina Nacional de Estadísticas de Cuba, 2011).

[17] Cuban crude oil is too vicious to be easily pumped or transported by pipeline and/or marine vessel. Typically, naphtha, condensate, or other diluents are added to improve the viscosity of the crude oil.

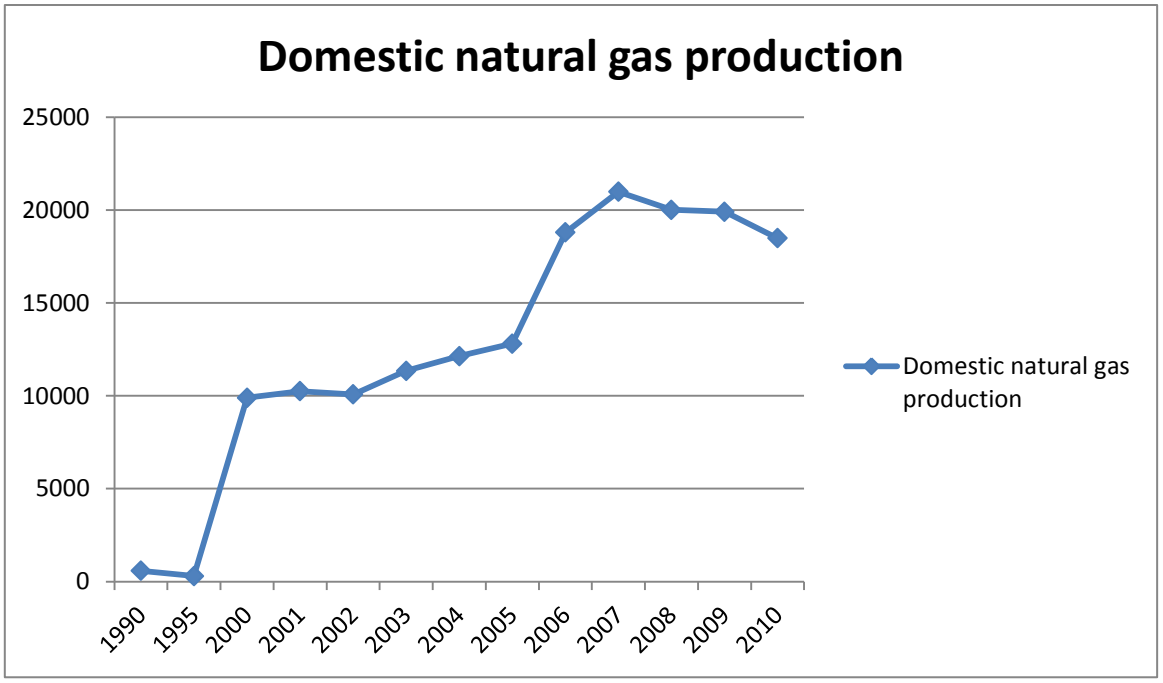


Figure 5.6: Cuba's natural gas production, 1990, 1995, 2000-2010, bbl/d equivalent (Author compilation, based on data from Oficina Nacional de Estadísticas de Cuba, 2011).

As discussed in section 5.2.3, however, Cuba's policy towards FDI has generally been encumbered with ambiguity (Feinberg, 2011, 2012; Villanueva, 2012). In the petroleum industry this is perhaps best illustrated with the aforementioned scrapping of Pebercan Inc. in 2009, a contract that was originally set to last until 2018. Nevertheless, and judging by the numerous co-signings of block licenses with various foreign oil companies in recent years, the Pebercan incident should not be interpreted as a general withdrawal from Cuba's openness towards foreign participation in the sector. Again, Pebercan had by 2009 transferred all of its contractual operations to Sherritt (Piñón & Benjamin-Alvarado, 2010). Stated differently, whatever role Pebercan had played in providing Cuba's petroleum sector with foreign technology, capital or access to markets had been taken over by Sherritt.[18]

Cuba's outward orientation has not been limited to investments from foreign oil companies in the exploration and production of oil. As part of the diversification of its international economic relations, the island state has reached out to forge economic relations with states in Europe, Canada, and – over the last decade – to major emerging economies like China, Brazil, and Venezuela.

[18] As stated in section 5.2.3, however, it have been argued that this reveals a pattern, showing that "when the Cuban state falls seriously into debt with an international partner, it may choose to close it down and wrap the arrears into a broader deal liquidating all assets." (Feinberg, 2012, p. 34). Although Sherritt have also experienced payment delays, it received US$74.1 million of the US$ 140 million that Pebercan received in the settlement, "as its share of the proceeds in respect of its interests in Block 7." (Sherritt International Corporation, 2012b).

In particular, the close relationship with Venezuela has been extremely favorable in that it both narrows down Cuba's bulging foreign exchange shortfalls (Feinberg, 2012), and maintain the financial sustainability of the heavily crude oil-dependent power sector (Belt, 2010). Depending on the international market price of crude oil, Cuba sends healthcare and other services to Venezuela as barter for 40-50 percent of the market value of the roughly 100,000 it receives a day. The remaining 50-60 percent is treated as a loan and financed for 25 years at one percent interest rate (J. Piñón, personal communication, February 15, 2013).[19] In effect, the barter agreement subsidizes Cuba's energy consumption by supplying Cuba with two thirds of its petroleum consumption, and close to all of its petroleum imports. With oil prices at above US$ 100 a barrel, it would cost Cuba close to US$ 3.7 billion a year if this oil were to be bought on the open market. In other words, the deal provides Cuba with a subsidy equivalent to a US$ 2-3 billion a year in annual cash infusion. For a country with merchandise exports of US$ 3-4 billion a year this is a very significant amount.

The special relationship that Cuba has enjoyed with Venezuela since the beginning of the 2000s has coincided with an increased favoring of fewer and state-owned foreign investors (Villanueva, 2012). At first glance the favoring of state-owned companies seems to apply to the petroleum sector as well. Judging by the groups of foreign oil companies with block concessions in Cuba (Figure 5.3 and 5.4), only Sherritt and Repsol are privately owned. The rest of the companies are either wholly owned by their respective home countries, or the home country is the major shareholder. Whether this has been a deliberate policy on the part of the Cuban government is difficult to conclude on, however. The only company with petroleum production in Cuba today, Sherritt International, is privately owned. Further, the company with the largest investments (Allen, 2012; Franks, 2012b) to date offshore, Repsol YPF, is also private.

5.3.2 Inward Transfers

Cuba has favored FDI as a measure to access foreign technologies and other knowledge-related assets as part of its outward orientation. The creation of a favorable formal institutional environment has contributed to a dramatic increase in domestic production of crude oil and associated natural gas. Several important technologies have been introduced in Cuban onshore and coastal upstream operations since the opening of the sector. Among the technologies introduced in Cuba's onshore and coastal upstream operations since the

[19] Other agreements have also been made, both with Venezuela and other countries, as will be discussed in section 5.3.

beginning of the 1990s are horizontal and bi-horizontal drilling technologies, auger drill bits, pumping units, seismic equipment, and enhanced recovery methods.

The facilitation of inward transfers to domestic actors seems to be institutionalized through the PSA. As stated, here the third-party contractor – or joint venture enterprise between the Cuban state entity and the foreign oil company – is responsible for supplying capital, equipment, installations, technology, and personnel needed to carry out the operations. As such, Cuba awards the right to explore and produce hydrocarbons at its soil to foreign oil companies, while seeking to create linkages and inward transfers between the foreign contractor and the domestic entity – which is Cupet – through the joint venture.

Much of the new technology stems from joint ventures with Sherritt in upstream oil and gas production, and in gas processing and distribution. Sherritt's petroleum reservoirs in Cuba are located in shallow and coastal waters, but close enough to the coast to access the reservoirs using directional drilling technology from onshore locations. In 2005, a Sinopec subsidiary, Great Wall Drilling Co., signed a service contract with Cupet to provide a number of bi-directional drilling rigs and other service equipment to be leased in conjunction by Sherritt and Cupet (Oil & Gas Journal, 2005; Reuters, 2005). Bi-directional rigs allows for drilling vertically and then horizontally or at an angel to access coastal reservoirs, and are currently used by Sherritt and Cupet in block 7. Sherritt has also implemented enhanced recovery technology to optimize the production of heavy oil in Cuba (Sherritt International Corporation, 2011), aiming at increasing recovery rates up from the current 7 percent.

Sherritt is also in a joint venture named Energas S.A. with Cupet and Unión Eléctrica – Cuba's state owned power enterprise – in the processing and distribution of associated natural gas found within domestic crude oil reservoirs (Sherritt International Corporation, 2011). The Energas joint venture, where Sherritt supplies all capital, technology and finances, has allowed for utilization of natural gas into power gas turbines. Otherwise the raw natural gas would have been flared at the reservoir sites, creating pollution and un-utilized (Sherritt Communications Department, personal communication, April 5, 2013). Sherritt has also introduced combined-cycle turbines at facilities in Varadero, which greatly enhances efficiency, while the same technology is to be installed at Boca de Jaruco. In 2011, Energas produced 1,853 GWh of electricity, representing some 11 percent of Cuba's electricity production (Sherritt International Corporation, 2011). The gas-fired facilities established under the Energas has contributed to a drop in the dependence of oil and other liquid fuels for energy production from 93 percent of the total, to 85 percent in recent years (Belt, 2010).

In 2009 Cupet concluded a number of PSA's with the Russian national oil company Zarubezhneft, which among others has led to exploratory drilling in block L. In 2011 another PSA was signed for pilot works, field follow-up exploration, and use of secondary enhanced recovery methods on the Boca de Jaruco field, one of Cuba's largest. According to estimates made by the Russian company the introduction of these technologies, using steam and thermal well treatment to reduce viscosity will allow for an increased recovery factor from 6 percent during 30 years of development to 36 percent in the next 25 years (Zarubezhneft, 2011). Further, through its company branch in Cuba, Zarubezhneft is performing annual transfers for the education of Cuban personnel in the framework of realization of the oil exploration and production project in block L (Zarubezhneft, 2011).

These are all examples on how Cuba has managed to create linkages and access inward transfers based on the attractiveness of its petroleum resources. This has often been sought through partnerships with foreign companies – in particular Sherritt International. Through joint ventures such as the Energas, employees in project activities have benefited from additional training in the operation and maintenance of the facilities (Sherritt International Corporation, 2011). Joint venture training programs such as this one is of particular value for the Cuban workforce, as the technologies applied here are generally not available through purely "domestic" activities (Cereijo, 2010).

To what extent the linkages created with foreign companies have contributed to increased capabilities among domestic actors in the petroleum sector is difficult to assess. As will be further discussed in section 5.4.1, however, in 2011 Cupet produced the bulk of Cuba's total crude oil production independently, in considerably larger quantities than the total levels of 1991. According to Piñón and Benjamin-Alvarado (2010) Cupet has also conducted exploratory work without foreign assistance in different areas east of Havana Piñón & Benjamin-Alvarado, 2010). Further, during my interview with Jorge Piñón, he stated that:

> they have learned a lot from Sherritt […] So the capabilities of Cupet from a technical point of view are good, but limited to the production of onshore and/or coastal reservoir of heavy oil, period. (J. Piñón, personal communication, February 15, 2013).

In a rare statement cited in the *Oil & Gas Journal* (2007), Carlos Lage Davila, a former member of Cuba's Politburo and secretary of the Council of Minister's Executive Committee, stressed that Cuba was increasingly able to service their own (onshore based) oil and gas industry. This also seems to be in line with another source, which states that many of the introduced technologies have been rapidly assimilated by the experienced Cuban

petroleum workforce (Cuban petroleum industry source). Lage Davila further stated that the country had twelve drilling rigs, allowing for control of wells belonging to Cupet, and to lease rigs to foreign companies. "We have five machines to repair wells [and] another two for the cementing process. All this shores up our own capacities, and it is something that we must continue to make progress on." (Carlos Lage Davila, cited in Oil & Gas Journal, 2007).

Judging by these statements, domestic capability building has been a recognized priority by Cuban authorities. Further, inward transfers of technology, industry know-how, and managerial skills has been sought and successfully assimilated through cooperation with foreign oil companies, of which Sherritt has been the most prominent.

In offshore operations, where Cuba has much less experience, transfers in the form of local employment, where Cupet engineers and rig workers come and work on the exploratory rigs seem to have been more prominent than technology transfers (J. Piñón, personal communication, February 15, 2013). However, there seem to have been side agreements that if production ever came on stream, technology transfers and additional training would take place. "But that would not take place before oil was found." (J. Piñón, personal communication, February 15, 2013). This also lends support to the view that sufficient basic entry conditions need to be in place before any such demands might materialize through a bargaining process.

Cuba does enjoy a favorable relationship with Venezuela on the other hand. Cupet and PDVSA share a number of onshore heavy oil projects, including the upgrading of the Cienfuegos refinery which will be discussed in section 5.4. None of these are in production, however. Thus, the transfer of knowledge and technology between actors in the petroleum sectors of the two nations is limited to onshore heavy oil, and in refining in particular (J. Piñón, personal communication, February 15, 2013).

Further, Cuban administrative and technical staff has attended courses in petroleum policy and resource management, and petroleum development operations held by the Norwegian Norad affiliate Petrad. Through the Oil for Development Programme Norad shares the Norwegian experience in petroleum sector management. By Cuban request, Norad and Cuba signed an agreement in 2011 for three annual workshops and seminars to be held until November 2013 (Norad, 2012). The economic framework for the program is relatively small compared with those of other countries. According to Petrad (2013), however, a workshop on local content is to be held in June 2013 (Petrad, 2013), signifying Cuba's aim to increase local participation in the sector.

Despite the mentioned linkages, Cuba's access to international petroleum industry knowledge networks generally seems very limited:

> Remember that today we learn with other companies and you need to learn from Statoil, Petrobras, Shell and we do that because we talk to each other and we do that because we have joint ventures, we go to congresses, we work together, we have the Halliburton's and the big companies, and that whole network is really where you get a lot of hands on experience. Cupet doesn't belong to that network. (J. Piñón, personal communication, February 15, 2013).

This is not just because of the U.S. embargo. In principle Cupet could go to Europe or initiate joint ventures with world leading companies such as Shell, but is restricted because Cuba lacks the money, offshore expertise, and projects to join such networks (J. Piñón, personal communication, February 15, 2013). In consequence, this means that Cuba's chances to facilitate inward transfers and linkages abroad is by and large limited to companies investing in its petroleum sector – which is off course dependent on petroleum discoveries at Cuban soil – and through its strategic cooperation with Venezuela – which is limited to onshore heavy oil operations.

After his ascendance to presidency, Raúl Castro soon travelled to countries such as Brazil, Algeria, Russia, and Angola (Havana Journal, 2009b), all notable oil producers and exporters. The trips were allegedly made to expand on its international petroleum networks, and reduce its dependence on imports from Venezuela:

> Because what he was afraid of – and they're still concerned today by the way, every time I go to Cuba I hear the same thing and they recognize this. They said that we have again put all of our oil eggs in one basked like we did during the 1980s, that we relied on the Soviet Union, and when it disappeared one day we found ourselves without oil. And they have done the same thing today. (J. Piñón, personal communication, February 15, 2013).

Cuba has not managed to negotiate any foreign ventures in the production of oil, however, with the exception of a five percent share in a small onshore block in Angola (EIA, 2013a). Allegedly this was a favor by the MPLA government who was assisted by Cuban forces during the civil war of the mid-1970s.

5.3.3 Domestic Linkages

Assessing to what degree Cuban policies promote domestic capability building by for example providing a system of supporting institutions and non-organizations is difficult due to limited information. It is clear, however, that Cuba has delegated considerable efforts to enhance the role of science and technology in the fulfillment of national development goals. In effect, Cuba has been able to develop a highly qualified labor force in many areas

(Domínguez, 2012; Sáenz, 2008). In addition, Cuba has since the first years of the Revolution placed special efforts in the search for petroleum (Benjamin-Alvarado, 2010).

As stated in section 5.1, the *Instituto Cubano del Petróleo*, established in 1961, had oil exploration as one of its main objectives. In its initial years the Institute, which made up the domestic petroleum-related knowledge base at the time, had little but two Cuban geologists. The science and technology work, such as the geological mapping of the main island, as well as the practical field search was directed by geologists and geophysicist from the East Bloc. Likewise, Soviet equipment was used in the processes and transferred at very favorable credit terms (Sáenz, 2008). Apart from the knowledge and technology transfer invested in Cuban, Cuban geologists and geophysicist were also sent to the Soviet Union for learning. Within 20 years Cuban specialists were capable of exploring for oil gas independently (Sáenz, 2008).

Still, the lack of equipment and spare parts, deterioration of specialized technical resources, and delayed investment programs beginning in the late 1980s had severely strained domestic capabilities by the beginning of the 1990s. According to one estimate, no less than an average of 90 percent of domestic production during this decade stemmed from fields reopened by foreign oil companies (Castellón, 2004). In 1998, however, eight of the 18 wells that were drilled were done with Cuban resources and included horizontal drilling technology (Castellón, 2004). The successful integration of foreign practices and technologies could not have been achieved without qualified domestic technical personnel. Of the 21,000 Cuban workers in the petroleum industry in 2004, more than 2000 held a technical degree from Cuban universities (Castellón, 2004).

As stated in section 3.1.1 and 3.1.3 in the context chapter, Cuba developed a formal national system of innovation during the economic hardships in the mid-1990s. The petroleum sector does not seem to be integrated in this system in any systematic and comprehensive way, however.[20] Nevertheless, in 1994 Cuba's Ministry of Basic Industries (MINBAS) completed a study aimed at identifying technological demands in different state enterprises located under the MINBAS umbrella. At the same time various technological possibilities offered by scientific and technological centers were mapped out. The results of the project, named *Integrated Management and Financing of the S&T Activity in the Ministry*, was implemented in 1995 (Sáenz, 2008). Here, strategic objectives in the Ministry were turned into projects that could be taken up by research groups. For the petroleum sector, enhanced

[20] Of the articles that I have reviewed (Jover et al., 2011; Jover & Arriete, In Press.; UNESCO, 2010) which consider Cuba's NIS contains no explicit mention of the petroleum sector.

recovery rates of the heavy crude oil and the utilization of associated natural gas for power production were the most notable projects.

Through the building of linkages between domestic state enterprises and research organizations that this project represented, it might be argued that a domestic Sectoral Petroleum System of Innovation had begun to emerge. It was not an exclusive petroleum system of innovation, however, as the MINBAS was in charge of a number of additional industries such as nickel and renewals. Further, with respect to the two projects above, both were only achieved through the participation of foreign oil companies.

5.3.4 Summary: Petroleum Technology Policies

As stated in the previous summary section (5.2.5), even though Cuba's relative bargaining power seems low, this does not preclude successful facilitation of inward transfers and domestic capability building if substantial discoveries are made in the future. At the same time it was argued that the facilitation of such processes heavily depended on Cuba's petroleum technology policy.

The empirical evidence suggests that, since the beginning of the 1990s, Cuba has favored a high degree of openness toward foreign participation in the sector. This was part of a broader change in the technology policy of the country which aimed at increasing the level of FDI in the economy. In the petroleum sector, this line of policy was targeted at attracting the participation of foreign oil companies to increase domestic production of oil and gas. This was especially pressing, as consumption vastly exceeded domestic production and the access to cheap oil from abroad was cut.

The shift in policy orientation was formally institutionalized through the legal framework on the national level, and in the commercially favorable PSA that Cuba offers foreign oil companies interested in exploring and producing petroleum in one of the country's onshore, coastal, or offshore blocks. Since the opening of the sector, production of oil and gas has increased seven-fold since 1991.

In general, however, it has been noted that while the institutional framework seems favorable towards FDI, Cuba has led an ambiguous policy on the matter (Feinberg, 2012; Villanueva, 2012). In the petroleum sector this is perhaps best illustrated by the Pebercan incident. On the whole, however, and judging by the recent cosigning of a number of foreign oil companies, this incident does not seem to have been part of a broader withdrawal from the openness-oriented policy.

In addition to the openness towards foreign participation, Cuba actively seeks to establish linkages with foreign oil companies to expand on the knowledge and technological base of its domestic actors. The interactions between Cuban state enterprises and foreign oil companies are structured through the PSA, where the third-party contractor – or joint venture enterprise between the Cuban state entity and the foreign oil company – is responsible for supplying the capital, equipment, installations, technology, and personnel needed to carry out the operations. As such the PSA is the main instrument of which Cuba facilitates inward transfers.

Through the joint ventures, a number of technologies such as bi-directional drilling rigs and enhanced recovery methods have been introduced. The training programs and involvement with new technologies have provided Cuban workers with greater opportunities to delve into DUI modes of learning. Further, the Cuban education system seem by and large to supply manpower capable of assimilating most of the introduced technologies in own operations. Most importantly, this has enabled Cupet to significantly increase its independent petroleum production since 1991.

Apart from the foreign oil companies investing in the petroleum sector and the strategic relationship with Venezuela, however, Cuba's access to foreign petroleum industry technology and knowledge – in particular the international knowledge network of various oil industry actors – is very limited. This is not just because of the U.S. embargo, which prohibits U.S. companies to engage in business activities in Cuba, but also because of Cuba's own lack of financial resources, attractive projects, and offshore expertise. Given the current economic situation, accessing these networks depend on major petroleum discoveries, of which chances after 2012 seem to have diminished significantly.

The details of Cuba's technology policy towards increasing linkages and enhancing the absorptive capacity of domestic petroleum sector actors are difficult to assess due to the data limitations on the subject. Nevertheless, the top national leadership has long emphasized the role of science and technology to spur economic and social development. Although the petroleum sector does not seem to be part of the formally established national system of innovation in any comprehensive and formal way, efforts to develop and expand on the domestic petroleum industry knowledge base have long figured high on the political agenda.

The expansion of the knowledge and technology base has, however, since the establishment of the *Instituto Cubano del Petróleo* been dependent on the participation of foreign actors. This was first secured through the strategic relationship with the East Bloc

(ONRM, 2013b; Sáenz, 2008), and since the beginning of the 1990s through a less discriminatory range of foreign oil companies.

This is not to say that efforts to enhance linkages between domestic actors have been generally neglected. During the 1990s efforts were also made to build linkages between domestic research organizations and state enterprises under the MINBAS umbrella. Some of the projects, such as the utilization of associated natural gas for electricity production and enhanced crude oil recovery rates, focused exclusively on enhancing capabilities in the petroleum sector. While the exact contribution of Cuban research entities to provide STI-based solutions to these and other challenges seem limited (see also section 5.4.1), the identification and targeting of these projects nevertheless appear to have played an important role to their solution: attracting and facilitating inward transfers from abroad, in these particular projects from Sherritt International.

From these considerations, two main points might be extracted to answer the second sub-research question:

What are the main components of Cuba's petroleum technology policy?

Since the beginning of the 1990s, *Cuba has favored a high degree of openness to the participation of foreign oil companies in its petroleum sector*.

This line of policy was chosen in order to spur domestic production of petroleum. Through the participation of foreign oil companies, *inward transfers and domestic capability building have been actively sought.* In the onshore-based petroleum sector, such inward transfers have been successfully facilitated and contributed to increasing the domestic capabilities among domestic actors in various activities.

How this has affected Cuba's relative bargaining power could not be assessed due to the lack of data on the details of Cuba's contractual agreements with foreign oil companies since the opening of the sector. While it seems highly likely that actors in Cuba's petroleum sector have increased their capabilities in various areas, not least in upstream operations, a comparison between different contracts over the timespan between the opening of the sector and the present time would have been necessary to assess any circular causality in the Cuban case.

To my knowledge, Cuba does not offer a different PSA regarding its offshore blocks, where Cuban actors are less capable. Rather, they seem to have sought and managed to achieve agreements on inward transfers if production ever came on stream, but the rate and

nature of these transfers could not be assessed. Further, regarding the offshore blocks the relative lack of capabilities might have been offset by the comparably higher perceived attractiveness of these blocks.

5.4 THE VALUE CHAIN OF CUBA'S PETROLEUM SECTOR

This section seeks to map out the different actors, activities, and linkages along Cuba's petroleum sector value chain. This is done in order to assess the main characteristics of the chain, its sources of value creation or lack thereof, as well as to further explore in what ways Cuba's openness toward foreign participation has facilitated inward transfers and domestic capability building.

5.4.1 Organizational Structure

To begin with, in Cuba the whole value chain – from the production of hydrocarbons, via processing, distribution and logistics, as well as marketing and sales – is in the hands of the state or state-controlled enterprises. As such, the cautious acceptance of private initiatives seen in recent years does not apply to activities in the petroleum sector.

The organizational structure of the sector is centralized, with the top national leadership in charge of entry regulations, targeting goals, outlining laws, and generating sectoral policies. A recent restructuring in the ministry performing state duties in the petroleum sector resulted in the newly established Ministry of Energy and Mining (MEM) (Cuban News Agency, 2012). The MEM replaced the old Ministry of Basic Industries (MINBAS). While the MINBAS was in charge of a vast range of industries, the MEM is to concentrate only on petroleum, electric power, and mining. According to Granma (2013), this was done to rationalize the activities of the Ministry for the promotion of energy security, and economic and social progress (Granma, 2013).

Under the Ministry, the *Oficina Nacional de Recursos Minerales* (ONRM) plays a major role in the regulation, supervision, and control of petroleum activities. The goal of the ONRM is to secure rational use mineral resources, and to exercise state control over geology, mining and petroleum activities. According to its own web page the ONRM was transferred to the new Ministry, with all its functions and powers (ONRM, 2013c). The ONRM is also in charge of hosting an international geology conference held in Havana every second year, where one section is specifically concerning petroleum geology systems (Geociencias, 2013). Under the ONRM is also the *Escuela Superior de la Industria Basica* which provides training

programs for managers and technical staff in the industries (Cuban petroleum industry source).

Under the new arrangements, the national oil company Cupet is still likely to be responsible for all up-, mid-, and downstream value-added activities, including in liquefied natural gas and basic petrochemicals. It is also likely to be accountable for its own international activities (Piñón, 2010). Through its commercial arm, Cupet is in charge of developing and entering into contracts and ventures with foreign oil and service companies (Unión Cuba-Petróleo, 2008). Foreign companies interested in exploration and production activities must, however, obtain a qualification certificate from the ONRM (Figure 5.7).

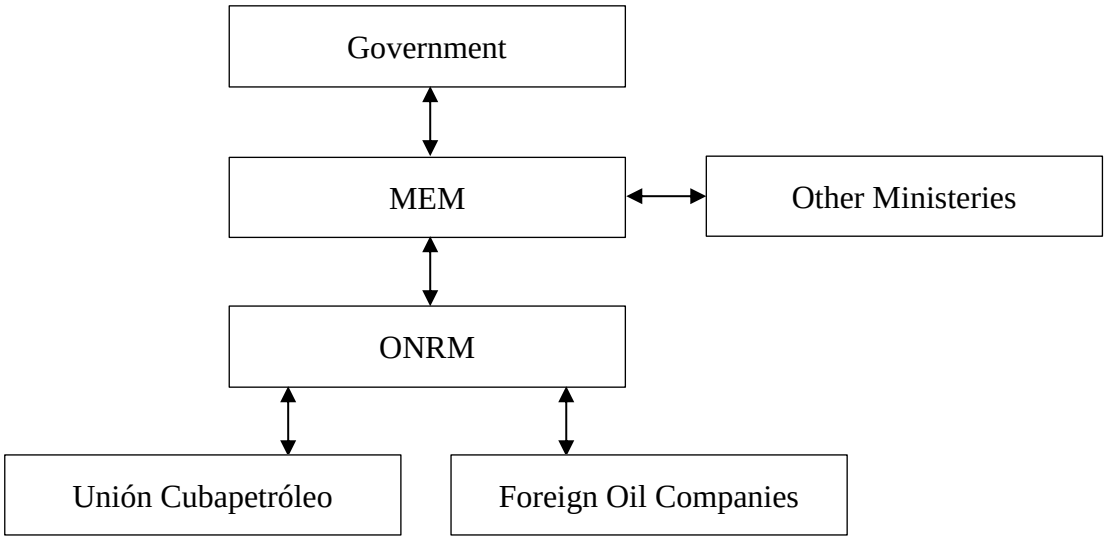


Figure 5.7: Organizational structure for the regulation of exploration and production activities in Cuba's petroleum sector.

Included in Cupet are several smaller companies with activities in petroleum engineering and projects, pipelines, storage, maintenance, and assembly (Unión Cuba-Petróleo, 2008). Under the umbrella of Cupet is also a petroleum research center, named *Centro de Investigaciones del Petróleo* (CEINPET). The objective of CEINPET is to conduct applied research, technological innovation, and advice in order to boost petroleum industry development. The institute appears to have had some success in developing technology for treatment of contaminated soils, in lubricants development, and related areas. Its scale and overall contribution to the creation and diffusion of new innovations and technologies appear limited, however: "The research institute is very poor […] they really play more the role of a laboratory. It's not a research institute that you and I would know it." (J. Piñón, personal communication, February 15, 2013).

5.4.1 Upstream

As stated, Cuba has 33 onshore blocks open for bidding, of which eleven were leased by foreign oil companies in 2010. Except from Cupet and Sherritt, the only substantial exploratory work that is conducted today is by Russia's Zarubezhneft. Zarubezhneft is currently leasing the Sogna Mercur drilling rig and explores for oil and gas in the deep shelf oilfields off Cayo Coco. The results of the exploratory drilling will not be presented until mid-2013.[21] Other foreign oil companies with onshore and coastal concessions have to date only conducted seismic works in their blocks. Thus the major actors in Cuba's upstream onshore and coastal industry today are Cupet and Sherritt International, the latter through production from onshore and coastal reservoirs within block 7. As shown in section 5.3.1 Cuba's domestic production has leveled at some 70,000 boe/d.

Much of the crude oil production results from the PSAs between the two, using directional drilling technology from onshore locations targeting coastal reservoirs one to five kilometers from shore (Piñón, 2010). Sherritt reported in its 2011 financial statement that gross working-interest production (production shared between Sherritt and Cupet) amounted to 20,888 bbl/d, which represented approximately 43 percent of Cuba's total crude oil production (Table 5.3).

PRODUCTION AND SALES

DAILY PRODUCTION VOLUMES (bbl/d)

For the years ended December 31	**2011**	2010	Change
Gross working-interest oil production in Cuba *	**20,888**	21,204	(1%)
Net working-interest production			
Cuba (heavy oil)			
Cost recovery	**3,430**	3,910	(12%)
Profit oil	**7,856**	7,218	9%
Total	**11,286**	11,128	1%

* Gross working-interest oil production is allocated between Sherritt and Cupet in accordance with production-sharing contracts.

Table 5.3: Sherritt's production and sales in Cuba, 2011, 2010, including cost recovery and profit oil (Adapted from Sherritt International Corporation, 2011, p. 43).

[21] Although the exploratory work conducted in Cuba by Zarubezhneft is in deepwater areas, the blocks leased by Zarubezhneft is categorized as a coastal block. Further, these activities are not part of the EEZ and not as deep as the exploratory wells drilled here in 2004, and 2012.

Of this production, Sherritt's share - or net working-interest production (which equals sales volume) - was 11,286 bbl/d. Production costs were US$ 12.07 per barrel whereas the realized sales price was US$ 68.47, suggesting that even with fractured and heavy oil reservoirs, a significant economic rent can be achieved in Cuba's onshore-based petroleum sector. All of Sherritt's oil sales go to a Cuban government agency. The realized price is a discount off US Gulf Coast fuel oil No. 6 (which 2011 average price was US$ 95.41) due to the low quality of the crude. The annual gross profit earnings before interest, taxes, depreciation, and amortization (EBITDA) were US$ 235.9 million – a 33 percent increase from the year before, primarily due to higher market prices for oil (Sherritt International Corporation, 2011).

According to my calculations, this leaves Cupet with an independent production of 27,688 bbl/d and a total of 37,290 bbl/d when the production from the PSA with Sherritt is included.[22] Cupet sells its petroleum production to the national electrical power company, Unión Eléctrica. In contrast with the oil sold by Sherritt, these prices are not reported and do not reflect world prices. It is, however, heavily subsidized in order for the cash-strapped Unión Eléctrica to be able to buy the oil. The electricity enterprise sells its generated electricity to end-users at lower prices than the costs of production. All of this make the efficiency of this part of the value chain low and difficult to measure (J. Piñón, personal communication, February 15, 2013).

Cupet and Sherritt have also established a highly successful joint venture along with Unión Eléctrica in the production and processing of associated natural gas, launched in 1997. The ownership of the venture is equally split between the three. The objective of the venture is to convert flared gas from the oil fields into fuel through a combined-cycle process, allowing Cuba to make use of the associated natural gas for on-site power generation plants. The process entails removing sulfur from the crude oil, utilizing the associated gas to fuel power turbines. Sherritt's role in the venture is to bring finance, capital and technology, whereas Cupet supplies the gas at no charge. Unión Eléctrica buys the power from the plants.

In 2011 Energas produced 1,853 GWh of electricity, which represented approximately 10 percent of Cuba's electricity production. The total capacity of the facilities stands at 356 MW, up from 173 MW in 2004. Plans to construct a new and expanded power facility at Boca de Jaruco have been initiated, and is expected to be operational in the first half of 2013. This will expand the power generation capacity to 506 MW (Sherritt International Corporation,

[22] These calculations are based on numbers from Sherritt's annual report from 2011 (Sherritt International Corporation, 2011). Cuba's only publishes total production numbers (Oficina Nacional de Estadísticas de Cuba, 2010), which includes diluents, meaning that the true crude oil production is somewhat less than reported.

2011). According to Cuban officials, natural gas recovery rates are approximately 94 percent (Piñón & Benjamin-Alvarado, 2010).

While it is true that the introduction of foreign technology and knowledge by Sherritt and others have increased hydrocarbon production, it has been estimated that Cuba could increase its domestic crude oil production to approximately 75,000 bbl/d. This could happen if Cuba was able to access the services, technology, equipment, and capital available through U.S. oil and oil services companies; increasing recovery rates from the current seven to somewhere between 17 and 20 percent (Piñón & Benjamin-Alvarado, 2010).

Offshore, Cuba has 59 exploration blocks up for bidding, of which 30 blocks were leased by late-2011. The only area that has been thoroughly explored with seismic data and analytical tools is the area closest to Cuba, where the three wells were drilled during 2012 (Piñón, personal communication, February 15, 2013). As stated, Cupet itself has very limited offshore experience. The same goes for Venezuela's PDVSA. The well it drilled in late-2012 was the first one that the company has conducted in deepwater areas (Piñón, personal communication, February 15, 2013). After the commercially unsuccessful wells drilled throughout 2012 Repsol, the company with the bulk of exploration investments in Cuba's EEZ pulled out. Currently no exploratory drilling is conducted in Cuba's EEZ, and the rig Scarabeo 9 – the only rig in the world capable at drilling at these depths without triggering U.S. sanctions – left Cuban waters in late-2012.

Currently the, no value-added activities are extracted from the offshore areas of Cuba's EEZ.

5.4.2 Midstream

Due to the viscous quality of the domestically produced crude oil, it has to be diluted before transportation. Cuban crude oil transportation is by pipeline, truck, railway or coasting vessels from the oil fields to storage centers at Matanzas and elsewhere. According to Cereijo (2010) the railway system is so deteriorated that coasting vessels have taken over most of the transportation (Cereijo, 2010). From the storage centers, the crude oil is barged off to different thermoelectric power plants across the country, and from there through the electrical grid to the end users. Overall, the energy infrastructure in Cuba – from refineries to power generating plants to electrical grids and local wiring – has been characterized as being in a state of advanced decay (Cereijo, 2010).

In relation with the utilization of natural gas, however, Cupet has built a system of pipelines from the Puerto Escondido and Boca de Jaruco fields. The pipelines transport natural gas to the thermoelectric power plant at Santa Cruz del Norte and to the city of Havana where it is utilized for electricity production (Piñón & Benjamin-Alvarado, 2010).

As for imports, the superport of Matanzas can dock tanker ships of up to 150,000 tons of dead weight. Beside Matanzas there are an additional ten smaller ports located across the country to receive oil and refined products by ships, and 17 warehouses or tanks for storage. In addition there is an oil duct connecting Matanzas to the newly restored refinery at Cienfuegos, supplying the refinery with Venezuelan crude (Cereijo, 2010).

5.4.3 Downstream

Due to the viscous and sulfur-rich quality of the domestically produced crude oil, Cuba's old and technically outdated refineries are not capable of processing it (Cereijo, 2010; Piñón, 2010). The oil that is refined in Cuba is thus imported crude, stemming from the barter agreement with Venezuela.

According to the *Guidelines* article 241, Cuba aims at increasing the crude oil refining capacity and achieve output levels that help reduce the importation of oil products (Sixth Congress of the Communist Party of Cuba, 2011). As of 2010 Cuba has an annual refining capacity of 6 to 9 million tons in four refineries with a refining capacity utilization factor at a low 60 percent. The other three – located in Havana, Santiago de Cuba, and Cabaiguan – have been targeted for upgrading, but as of May 2013 no modification of these seems to have been conducted. In consequence, the domestic crude oil is transported to different thermoelectric power plants and burnt directly as crude, which has done severe damage to the plants and hence deteriorated their operating efficiency (Castellón, 2004; Cereijo, 2010). The inability to convert the crude oil (which in itself has little end-use value) into usable products severely hampers value addition at this stage.

Through *Cuvenpetrol S.A.*, a joint venture between Cupet and PDVSA, however, the Cienfuegos refinery, Cuba's largest of the four, came back on stream and is currently running Venezuelan Meza 30 crude, which is a bit lighter than the domestic Cuban crude. The refinery has been producing some fuel oil which is now distributed to some of the thermoelectric power plants (Piñón, personal communication, February 15, 2013). The Cienfuegos refinery is also to develop gasoline, turbo combustible, diesel, and liquefied petroleum gas. Any refining

upgrades in Cuba will be limited by the U.S. embargo, however, as the cutting-edge technologies – especially in the refining of heavy oil – are in the hands of U.S. companies.

In 2011 China and Cuba signed a letter of intent to invest some US$ 6 billion to further expand the Cienfuegos refinery. If implemented, this will more than double the current refining capacity from 65,000 bbl/d to some 150,000 bbl/d, and be the largest single overseas investment ever made in Cuba. For the moment, the investment plans appear to be on hold as future supplies from Venezuela seem uncertain, and because of the failed exploration efforts during 2012 (Franks, 2013).

As part of the overhauling of its aging thermoelectric power plants, Cuba is in progress of converting some of the old plants to run on natural gas instead of oil. A US$ 400 million regasification facility is planned at Cienfuegos. This will allow imports of liquefied natural gas to be re-gasified, and then make the Cienfuegos refinery, power plant and petrochemical prospect run on natural gas (Cereijo, 2010; Piñón & Benjamin-Alvarado, 2010). For Cuba, such projects are important in that natural gas is much cheaper to import, and less pollutant.[23] Again, however, the regasification plant would be limited by the U.S. embargo given that the most advanced technology today is located in the U.S.

5.4.4 Petrochemical Industry

In the *Guidelines,* Cuban authorities state that it has plans on further develop the Cienfuegos industrial park, aiming among others at producing petrochemical products such as ammonia and urea (Sixth Congress of the Communist Party of Cuba, 2011), both of which can be applied as fertilizers in agricultural production. The planned petrochemical plant is to be built through the *Cuvenpetrol* joint venture between Cupet and PDVSA, and located next to the refinery complex.

It has been noted that the petrochemical complex might provide important job opportunities for educated technicians (Grogg, 2011), and reduce imports of such products. As such it is in line with the general import substitution policy of the country. However, the planned scale of only 2000 tons a year will fail to achieve economies of scale, thus leaving the

[23] Based on an energy equivalent basis, crude oil and natural gas prices should have a 6 to 1 price ratio. Due to various market characteristics, however, the price of oil had typically trades 8-10 times that of natural gas in the past 25 years, when comparing US natural gas (Henry Hub) with the West Texas Intermediate reference crude oil. Since 2009, the historical pattern has started to deteriorate due to a combination of rising domestic production of unconventional shale gas, and geopolitical events in the Middle East & North Africa Region. In 2009-2012, the average ratio was 21.2 to 1; in 2012 up to 52 to 1 (EconMatters, 2012).

complex uncompetitive in an open market (Piñón, personal communication, February 15, 2013).

5.4.5 Services and Equipment

To date there is no independent oilfield services and equipment sector in Cuba. Although smaller state enterprises located under the Cupet umbrella are conducting maintenance in different fields, Sherritt has to seek abroad for equipment: "When Sherritt needs something they have to get it and import it, and Cupet has to run it." (Piñón, personal communication, February 15, 2013). All in all, the prospects of a service and equipment sector similar to the one developed in Norway looks rather dim, because of Cuba's lack of steel and manufacturing capabilities. In addition, such a sector would have to face fierce competition from a range of supply centers along the Gulf Coast and the Caribbean, such as in Mexico and Trinidad & Tobago if Cuba opens its economy.

5.4.6 Environmental Considerations

Environmental considerations are not included in the formal petroleum value chain presented in the theory chapter (Figure 2.1), and the approach has been criticized for the lack of emphasis on this area (Bridge, 2008).

According to the *Guideline's* article 218, special attention is to be paid to the environmental impact associated with current and future projects in the oil and petrochemical industries (Sixth Congress of the Communist Party of Cuba, 2011). In general, environmental considerations seem to be of high priority, not least because an offshore oil spill like the Deepwater Horizon could have severely damaged the economically very important tourist industry. In consequence, Cuba has cooperated on these issues within the confinements of Norway's Oil for Development program (Norad, 2012), in addition to Brazil and even the U.S government on how to manage a potential Deepwater Horizon catastrophe in Cuban waters (Piñón, personal communication, February 15, 2013).

According to a report made by the International Tanker Owners Pollution Federation Limited report (2008), the overall responsibility for oil spill responses resides within the National Civil Defense Office. Small and medium spills are handled by the facility or municipal authorities respectively, while in major incidents the responsibility is passed on to the National Civil Defense Office. Cupet is responsible for responding to spills from its own installations or in vicinity installations. It has five regional response centers located close to

the major oil fields equipped with skimming vessels, skimmers, boom and vacuum trucks. In addition Cupet has links with Pemex of Mexico, PDVSA, and Recope of Costa Rica for the exchange of equipment and expertise (ITOPF, 2008).

As for climate considerations, the high proportion of electric power generation from the burning of liquid fuels results in very high emissions (Belt, 2010). According to Sherritt (2011), work to reduce emissions in different production batteries through improvements and updates of operating equipment, are undertaken to meet Cuban environmental regulations (Sherritt International Corporation, 2011). Further, the utilization of natural gas for power generation has allowed for the capture of emissions and particulates that were previously discharged into the environment (Belt, 2010). This was particularly important considering that the air and visual pollution stemming from the flared gas was located close to the tourist sensitive areas of Varadero (Piñón & Benjamin-Alvarado, 2010). In general Cuba seems to try to keep their oil fields and refineries clean, but are limited by restrictions in capital and technology (Piñón, personal communication, February 15, 2013).

5.4.7 Summary: Petroleum Sector Value Chain

The empirical evidence shows that in Cuba, the whole value chain is in the hands of the state through state-controlled enterprises and non-firm administrative and bureaucratic organizations. There is no room for domestic private enterprises. The Cuban state, through the MEM and ONRM regulates entry conditions by issuing licenses in exploration and production activities. The notable domestic enterprises are Cupet, the national oil company, and Unión Eléctrica, the state-owned electricity utility. The latter is involved in the chain through its purchase of oil and natural gas, and through its distribution of electricity to end costumers. Cupet on the other hand, is in charge for all value-added activities along the chain. Through its commercial arm, Cupet develops and enters into contracts and ventures with foreign oil companies.

In upstream activities, Sherritt is involved both in the production of oil and gas and, through the Energas joint venture, it also has activities involving gas processing. Further, the Venezuelan national oil company PDVSA is involved in various downstream activities through the Cuvenpetrol joint venture, in particular in refining, but also in upgrading and establishment of complexes in regasification and in the petrochemical industry.

Further, the nature and type of the established linkages with foreign oil companies can be categorized into two general types. First, ‘market oriented’ linkages are mainly found in

upstream activities, where currently only Sherritt is the foreign participant. Here, the interactions are structured according to the PSA between the Cuban state entity and foreign oil company. In the market oriented linkages Cuba trade parts of the economic rent in return for increased domestic petroleum production, and inward transfers of technology and knowledge. In the case of the PSA with Sherritt, this amounted to some 54 percent of gross working-interest oil production (cost oil + profit oil) before taxes (25 percent of personnel salaries, 30 percent on net profits). As for the natural gas, the foreign company receives no allocation of the production. In the case of Sherritt, however, its one third interest in the Energas joint venture generates income from the gas sold to Unión Eléctrica. Judging by data from Sherritt's 2011 annual report, Sherritt has earned significant profits through its petroleum assets in Cuba (Sherritt International Corporation, 2011).

The second type of linkages can be called 'strategically oriented', and stem from Cuba's close relationship with Venezuela. The current aim of this linkage is to increase Cuban capabilities in crude oil refining, regasification, and in petrochemicals. Adding to this is of course the barter agreement, which subsidize Cuba's entire production deficit. Here, petroleum rents are imported to Cuba, partly in exchange with Cuban healthcare and other services. The strategic relationship with Venezuela contributed to the upgrading of the Cienfuegos refinery, which is currently running on Venezuelan crude. It has also led to the planning of a regasification facility located close to the refinery, which would make the refinery, power plant, and petrochemical complex run on cheaper and less-pollutant natural gas.

In general the joint ventures have been highly successful in many respects. They have among others contributed to significant increases in production levels, inward transfers of technology and knowledge, reduction in pollution levels, increased electricity production, and increased refining capabilities.

There are, however, a number of bottlenecks and limitations to value creation along the chain. First, one of the major inefficiencies of Cuba's petroleum sector value chain is that the crude oil and natural gas sold by Cupet to Unión Eléctrica are heavily subsidized or, as in the case of natural gas, supplied at no charge. In consequence there are no internal price transfer mechanisms reflecting world oil prices, which hamper incentives and efficiency.

Second, the U.S. embargo impedes a range of activities along the value chain. In upstream operations the embargo has made petroleum exploration in Cuba more expensive and difficult to pursuit, particularly offshore. The lack of access to U.S. oil and oil services companies have also been a contributing factor to the prolonged low crude oil recovery rates.

In addition, any production will be inhibited by the lack of access to the huge and closely-located U.S. consumer market. Upgrades of various complexes downstream and in mitigation are further limited by the lack of access to frontier U.S. technology.

Third, a major limitation of Cuba's petroleum value chain is that the domestically produced crude oil cannot be processed at Cuban refineries. This was attempted during the 1990s, when the abrupt loss of 41 percent of oil imports caused frequent blackouts and civil unrest. The result was that the sulfur-rich heavy crude oil caused severe damages on the plants, making them operating at a low 47-50 percent of installed capacity between 1990-1997 (Cereijo, 2010). In other words, refining is not part of the domestic crude oil value chain at all, and only adds value through the crude oil imports from Venezuela.

Fourth, intentional agreements, e.g. with China in further expanding the Cienfuegos refinery have not yet been materialized due to the unsuccessful exploratory wells drilled during 2012, and the uncertainties surrounding Cuba's future relationship with Venezuela.

Returning to the third sub-research question of this thesis:

> ***What is the division of tasks between Cuban and foreign actors along Cuba's petroleum sector value chain?***

The most basic finding in this section is that in Cuba, *the whole petroleum sector value chain is in the hands of the state or state-controlled enterprises*. With respect to activities along the value chain, Cupet – the national oil company – operates at all stages, and produced some 57 percent of total domestic oil production in 2011, excluding its share in the PSA with Sherritt. The other central domestic actor with activities along the chain is Unión Eléctrica which purchases the oil and gas and distributes the electricity to end consumers.

On the other hand, there *is a small number of joint ventures with foreign oil companies along the chain.* The participation of foreign oil companies has been actively sought and institutionalized to contribute to increased total domestic production of crude oil and natural gas. Foreign participation has also been sought to increase domestic capabilities at different stages on the value chain, in particular in upstream oil and gas, crude oil refining and natural gas processing, and in petrochemicals. Of the foreign oil companies, Sherritt is involved in the production of oil and gas, as well as in gas processing, whereas PDVSA is involved in various facility upgrading downstream as well as in the petrochemical industry.

5.5 CUBA'S PETROLEUM SECTOR OF INNOVATION AND PRODUCTION

Based on the preceding empirical analysis, this section seeks to characterize the building blocks of Cuba's petroleum sector of innovation and production. Subsequently, the findings are gathered to answer the main research question of this thesis.

5.5.1 Building Blocks

The main characteristics of Cuba's petroleum sectoral system of innovation and production will be assessed according to the different building blocks of sectoral systems of innovation presented in section 2.1.1 of the theoretical chapter.

As stated in that section, *knowledge bases and learning processes* are central for agent's innovative abilities. Knowledge varies in terms of *accessibility* and *cumulativeness*. As was theorized, in the petroleum industry, knowledge – in the form of e.g. technological know-how and managerial skills – has traditionally been difficult to acquire for host state actors. This has been both due to asymmetrical bargaining power, and a high degree of cumulativeness of industry knowledge. In consequence, a pattern of Schumpeter Mark II has characterized the international oil industry, creating large entry barriers and favoring already established firms with experience, economies of scale, and financial resources.

Through a strategic relationship with East Bloc countries, however, actors in the Cuban petroleum sector early on managed to learn and expand on their knowledge bases.

At the beginning of the 1990s, then, actors in Cuba's petroleum sector already possessed a considerable amount of absorptive capacity through its experience in onshore-based, heavy crude oil operations. It had acquired the knowledge and skills needed to conduct some exploratory activities without foreign assistance, while maintaining a domestic and vertically integrated onshore-based petroleum sector value chain.

Nevertheless, after the abrupt collapse of the Soviet Union, a cash-strapped Cuba produced only some 11-12,000 bbl/d of crude oil, a level exceeded by domestic consumption with well over 200,000 bbl/d. The deficit could not be financed through imports, even at a time where international market prices for oil were relatively low (see Appendix 2). As a result, Cuban authorities targeted increased domestic petroleum production as one of their main goals. In relation, it was acknowledged that the participation of foreign companies, with capabilities superior to domestic actors was needed to achieve this goal.

In other words, the high level of domestic *demand*, paired with constraints in domestic capabilities and *technological environment* provided the Cuban authorities with strong

incentives to seek the *inputs* of foreign oil companies in the petroleum sector. The decision was done based on the problem at hand; the need to reduce the gap between domestic production and domestic consumption, and the inability of domestic enterprises – in effect Cupet – to sufficiently reduce this gap.

In relation, during the 1990s the *formal institutional framework at the national level* was adapted to meet the needs of the sector, targeting inward transfers to attract new technology, knowledge, and capital to boost domestic petroleum production. This serves as a clear example on how needs and characteristics of a strategic sector affect and changes institution at the national level. In turn, the changes made at the national level, particularly in the form of a new law of foreign investment and contractual framework, shaped the characteristics of the petroleum sector; *creating variety* by introducing new companies, and with them new managerial-skills and technologies.

Corresponding with the efforts to attract foreign participation, attempts were also made to increase domestic linkages between government enterprises and research entities during the mid-1990s. Through the Integrated Management and Financing of the S&T Activity in the Ministry, technological demands in state enterprises were identified and given to research organizations. The contribution of domestic research organizations to the solution of the identified problems seemed limited however, as seems to be the case when assessing their contribution to the creation and diffusion of innovations in general.

Otherwise, the *types and structure of interactions among heterogeneous firms and non-firm organizations* are relatively untypical in Cuba's petroleum sector. A high degree of state control shapes the strategies and goals of the state-firms. The state-firms are further limited to Cupet and its umbrella of smaller entities performing various tasks along the value chain, and Unión Eléctrica which buys the output. Any possibility of variety creation through the introduction of new firms along the value chain seems very limited. This leaves processes of *selection* and *variety creation* regarding domestic firms virtually non-existent. In effect this greatly reduces the dynamism of the domestic parts of Cuba's petroleum sector.

The dynamism that does exist in Cuba's petroleum sector seems in large to be created through the participation of foreign oil companies in the sector. In this respect, Cuba has favored a policy aimed at increasing domestic petroleum sector capabilities through inward transfers of technology and knowledge from foreign oil companies. In particular, this has been institutionalized through the PSA that Cuba offers foreign contractors, and the engagement of Cuban state enterprises in various joint ventures along the petroleum sector value chain.

5.5.2 Domestic Capability Building and Inward Transfer

Based on the empirical analysis from the preceding sections, this section seeks to answer the research question of this thesis:

> ***What characterize the processes of domestic capability building and inward transfer of knowledge and technology in the Cuban petroleum industry?***

By virtue of its petroleum resources, Cuba has since the opening of the petroleum sector to foreign participation in 1993 managed to attract the interest of a wide range of foreign oil companies. On this basis, Cuba has sought to access the technology and knowledge held by these companies, and has through its institutional framework sought to facilitate inward transfers to domestic actors in the petroleum sector. The goal of this policy seems to have been to develop indigenous capabilities at various stages along the petroleum sector value chain. Correspondingly, Cuba's petroleum technology policy has also sought to facilitate linkages between various domestic actors, such as between state enterprises and research organizations, while supplying the industry with manpower capable of absorbing the inward transfers.

Nevertheless, the scale of the inward transfers is in particular limited by Cuba's petroleum resources. Currently only two companies are investing substantially in Cuba, with only one carrying out petroleum production (Figure 5.8). Furthermore, Cuban actors are largely excluded from the international petroleum industry knowledge network. As such, *the processes of inward transfer of technology and knowledge in the Cuban oil industry are limited to whatever agreements Cuba manages to strike with foreign oil companies investing in its sector*.

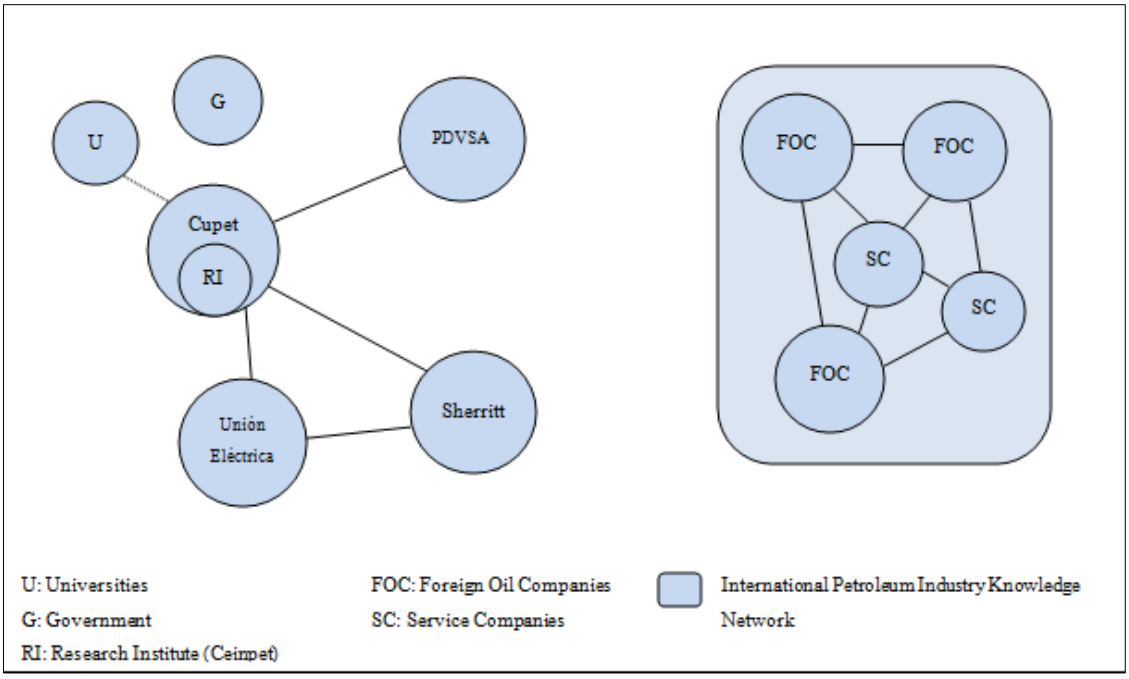


Figure 5.8: Cuba's emerging petroleum system of innovation. Note the lack of linkages to the international knowledge network, and the relative lack of linkages between domestic actors.

Currently, Cuba's low relative bargaining power seems to be reflected in its favorable PSA. In effect, Cuba offers a large share of the petroleum rent to attract foreign participation in the sector in order to spur domestic petroleum production. In addition, actors in Cuba's petroleum industry are closely cooperating with the Venezuelan oil company PDSVA. *Through these agreements, domestic actors in Cuba's petroleum sector, most notably Cupet, have managed to expand on their knowledge and technology base, and increased their capabilities.*

Through these linkages, actors in the Cuban petroleum industry are conducting so-called DUI forms of learning. While the exact learning processes undertaken through these interactions are difficult to access, one of the major results has been an increase in independent production of crude oil, from 11,671 in 1991 to 27,688 bbl/d twenty years later – an achievement undertaken in a period where the main fields were in natural decline.

This would not have been possible without a sufficient amount of absorptive capacity among Cuban industry actors. As such, although the level of research capabilities in Cuba's petroleum sector seems low, the Cuban educational system seems to supply the industry with manpower qualified of absorbing the inward transfers.

6. CONCLUSION

Innovation and innovation system studies have traditionally not dealt with natural resource industries in developing countries. This seems to be the case even when considering strategic industries such as the petroleum industry, where countries with abundant endowments have been struggling to transform their hydrocarbons into sustained economic growth and development.

This thesis has sought to address the void in the literature by applying the sectoral systems of innovation perspective and complementary approaches on Cuba's petroleum industry. This was done in order to explore the main characteristics of the industry, as well as to assess is opportunities for growth.

A main argument throughout the thesis was that if Cuba is to expand on its small-scale and onshore-based petroleum sector, it would be well-advised to formulate a technology policy aimed at accessing the technology and knowledge held by foreign industry actors. At the same time it was acknowledged that the successful access to and facilitation of such transfers would be difficult to achieve, depending among others on the relative bargaining power of Cuba as a host state, whether Cuba's petroleum technology policy included demand for such transfers, and finally on the ability of Cuban actors to assimilate and exploit the transfers.

On this backdrop a case study of Cuba's petroleum industry was conducted, aiming at answering the following research question:

> ***What characterize the processes of domestic capability building and inward transfer of knowledge and technology in the Cuban petroleum industry?***

In order to approach an answer, three sub-questions were formulated:

> ***What is the basis of Cuba's bargaining power versus foreign oil companies?***
>
> ***What are the main components of Cuba's petroleum technology policy?***
>
> ***What is the division of tasks between Cuban and foreign actors along Cuba's petroleum sector value chain?***

6.1 MAIN FINDINGS

The first sub-research question was posed in order to explore the basis of Cuba's opportunities to access foreign technology and knowledge, while grasping a proportionate share of economic rent:

What is the basis of Cuba's bargaining power versus foreign oil companies?

Relative bargaining power concerns *upstream* activities, where most of the *economic rent* stemming from petroleum-rich land is extracted. This thesis have argued that the relative bargaining power of host states is not only crucial for rent distribution, but also for the leverage of host countries to access technology and knowledge held by foreign oil companies interested in investing in upstream activities on their soil. By successfully facilitating inward transfers of technology and knowledge from foreign oil companies – making domestic actors capable of conducting petroleum sector activities without foreign assistance – the host state will, *ceteris paribus*, be better positioned in future bargaining processes.

In a Cuban context, given the country's limited access to multinational financing sources and bilateral credit, this channel of inward transfer seems especially crucial.

The main finding from this section was that Cuba's limited level of proved resources and the unsuccessful exploratory work done in its EEZ, paired with a high dependence on the resources of foreign oil companies and a generally unfavorable host country context, form a basis of a:

(i) Weak relative bargaining power for Cuba versus foreign oil companies.

While the current relative bargaining power of Cuba seems low, significant petroleum reservoirs might be discovered in the future. As seen in the cases of Norway and Angola, if large reservoirs are discovered, a high dependence on foreign oil companies does not preclude the successful development of domestic capabilities, even in challenging offshore operations.

For Cuba, if offshore production ever comes on stream, the petroleum technology policy of the country would be well-advised to actively seek inward transfers of knowledge and technology from the foreign oil companies, aiming at increasing domestic petroleum sector capabilities. In parallel, inward transfers of this kind – if accessed – are difficult to successfully *facilitate*, in other words effectively assimilated and exploited by domestic actors. Claiming that the absorptive capacity of sectoral actors is influenced by 'systemic'

factors such as the national policy and institutional framework, the second sub-question of this thesis was:

What are the main components of Cuba's petroleum technology policy?

The main findings are:

(i) Cuba has favored a high degree of openness to foreign participation in its petroleum sector since the beginning of the 1990s.

(ii) Inward transfers and domestic capability building have been actively sought through joint ventures and PSA agreements with foreign oil companies operating in Cuba's petroleum sector.

The openness towards foreign participation was chosen in order to attract FDI into the sector, aiming at boosting domestic petroleum production. As such Cuba has outlined a favorable formal institutional framework for this type of investment, as expressed by its foreign investment law and PSA. Through its contractual framework, it appears that Cuba actively seeks to expand on the domestic knowledge and technology base, by establishing linkages to facilitate inward transfers of technology, industry know-how, and managerial skills between the Cupet and the foreign oil company in question.

As for domestic capability building, this seems to have been a priority since the nationalization of the sector in the early-1960s. Since the early stages, this has been sought achieved through the establishment of linkages with foreign actors. Until the mid-1980s, through the strategic relationship with the East Bloc; after the collapse of the Soviet Union through a less discriminative and more market oriented policy, targeting different private and public oil companies by offering blocks open for bidding.

The petroleum sector does not seem to be integrated with the national innovation system in any formal and comprehensive way. Nevertheless, in the mid-1990s efforts were made under the MINBAS umbrella to facilitate linkages between state companies in the basic industries and various research entities. This might resemble some of the measures that were made under the maturation period in the petroleum innovation system of Norway, but the *Integrated Management* project was not exclusively focused on the petroleum sector. Further, the exact contribution of domestic actors on the technical solution of the identified projects seems limited.

In order to further explore the processes of domestic capability building and inward transfers, various activities, actors and linkages of the Cuban petroleum system of innovation and production, the following question was posed:

> ***What is the division of tasks between Cuban and foreign actors along Cuba's petroleum sector value chain?***

The main findings are:

(i) In Cuba, the whole petroleum sector value chain is in the hands of the state.

With respect to value-added activities along the chain Cupet, the national oil company, operates at all stages. There is no room for private domestic actors. The other central domestic actor is Unión Eléctrica, the state-controlled electricity utility, which purchases the oil and gas and distributes the electricity to end consumers.

On the other hand:

(ii) There are a number of joint ventures with foreign oil companies along the chain.

The nature of the established linkages with foreign oil companies can be sorted in two types: *(i)* 'market oriented' linkages, particularly found in upstream activities where Cuba trades parts of the economic rent in return for increased domestic production, as well as for inward transfers of technology and knowledge, and; *(ii)* 'strategically oriented' which stems from Cuba's strategic relationship with Venezuela. The aim here is to increase domestic capabilities in crude oil refining, regasification, and in petrochemicals. Adding to this is of course the barter agreement, which subsidize Cuba's production deficit versus its consumption. Here, petroleum rents are imported to Cuba, partly in exchange with Cuban healthcare and other services.

In upstream operations, Sherritt is the only foreign oil company with oil and gas production today. Through the Energas joint venture it also has activities in the processing of natural gas. Further, the Venezuelan national oil company PDVSA is involved in various downstream activities through the Cuvenpetrol joint venture, in particular in crude oil refining, but also in the upgrading and establishment of complexes in regasification and in the petrochemical industry.

It was added that there are a number of bottlenecks and limitations to value creation along the chain, relating to *(i)* the lack of market transfer in the petroleum sold from Cupet to

Unión Eléctrica; *(ii)* impediments on a range of activities and upgrades stemming from the U.S. embargo; *(iii)* the lack of capabilities in Cuba to refine the domestically produced crude; and *(iv)* the impediments to further investments and upgrading stemming from the disappointing exploratory results in 2012, and the uncertainties surrounding Cuba's future relationship with Venezuela.

Based on the findings from the three sub-research questions, the main research question of the thesis was answered:

> ***What characterize the processes of domestic capability building and inward transfer of knowledge and technology in the Cuban petroleum industry?***

Through its petroleum technology policy, Cuba has sought to access foreign technology and knowledge to build domestic petroleum sector capabilities. However, the scale of the inward transfers is limited by Cuba's petroleum resources, and its lack of access to the international petroleum industry knowledge network. As such:

(i) The processes of inward transfer of technology and knowledge in the Cuban petroleum industry are limited to whatever agreements Cuba manages to strike with foreign oil companies investing in its sector.

Through its PSA and contractual framework, however, Cuba has managed to link up with a small number of foreign oil companies investing in its sector. Currently, the amount is limited to Sherritt International. In addition, Cuban actors are also cooperating with PDVSA through its strategic relationship with Venezuela:

(ii) Through these agreements, domestic actors in Cuba's petroleum sector, most notably Cupet, have managed to expand on their knowledge and technology base, and increased their capabilities.

The learning conducted through these linkages would not have been possible without a sufficient level of absorptive capacity among Cuban industry actors. As such, although the level of research capabilities seems low, the Cuban educational system seems to supply the industry with manpower capable of absorbing the inward transfers.

6.2 PROSPECTS

Cuba has led a petroleum technology policy aimed at increasing domestic capabilities along the petroleum industry value chain. Its relative bargaining power towards foreign oil companies has been hampered by various factors, however, with the perceived attractiveness of its petroleum resources having been the most fundamental. Despite different risks and inherent difficulties associated both with the U.S. embargo as well as domestic risks, a whole range of international oil companies stood in line to hire the Scarabeo 9 in 2012, when prospects for offshore oil was perceived to be promising.

External factors such as perceived attractiveness of petroleum resources and, in the case of Cuba; the U.S. embargo, will be difficult to alter. However, the EEZ, having the largest hydrocarbon potential is relatively underexplored. A further exploration of the whole area might contribute to increase the attractiveness of the EEZ, although advanced exploration techniques at these depths generally requires the participation of experienced multinational oil companies. Further, Cuba should reduce the ambiguity towards foreign investments, as have also been seen in the petroleum sector.

With today's gas prices, and prospects for additional gas production in counties such as Angola, Nigeria, the Middle East, Argentina, and the U.S. now with shale gas, chances are that the prices for natural gas will be low also in the foreseeable future. Thus projects such as the planned regasification facility in Cienfuegos to make the refinery and power plant located there seem very sound in this regard. This will make the running of both the refinery and plant much cheaper and effective, while avoiding many of the negative environmental and wear-and-tear associated with the domestic crude oil. All the more, this makes sense given the high insecurities associated with Cuba's future relationship with Venezuela.

6.3 CONTRIBUTIONS, POLICY AND RESEARCH IMPLICATIONS

The contributions from this thesis can be summarized as follows. First, it has shown that the combination of different theoretical frameworks works as to study the processes domestic capability building and inward transfers in a developing country context. As such, it has contributed to expanding the academic knowledge of these processes in Cuba's petroleum industry. An important finding in this regard has been that Cuba, despite being situated in a weak relative bargaining power position, has managed to access and facilitate inward transfers. It was suggested that this could in part be attributed to Cuban absorptive capacity in the petroleum sector. Whether this finding can be extended to other petroleum-rich countries, would be an interesting line of inquiry for further research.

Second, by emphasizing the role of power relations and the international dimension, the thesis addresses some of the main limitations associated with the sectoral system of innovation framework. The thesis also addresses some of the voids in the literature by focusing on a natural resource-based industry in a developing country.

Third, a new model concerning the circular causality between host state relative bargaining power and capabilities have been formulated. While the lack of data on the details of Cuba's contracts with foreign oil companies since the opening of the sector has made it difficult to identify a process of circular causality in this country, the model is thought to be applicable to other petroleum-rich countries. In relation, this thesis has argued that such a process seem to have played an important role for the successful development of the petroleum sectors of two countries as different as Norway and Angola, thereby increasing the national value-addition stemming from petroleum activities in these countries.

Nevertheless, further research on the role of domestic capabilities and inward transfers in petroleum-rich countries are needed to confirm or discard its main propositions and implications in different host country contexts.

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APPENDIX 1

GLOSSARY OF OIL TERMS

The glossary presented here is mainly adapted from the book *Escaping the Resource Curse* (2007), edited by Macartan Humphreys, Jeffrey D. Sachs, and Joseph E. Stiglitz: New York, Columbia University Press. Further, the glossary presented in this book was largely written and assembled by David Johnson and Daniel Johnston. See for instance, Johnstion, David (1994). *International Petroleum Fiscal Systems and Production Sharing Contracts.* Tulsa: PennWell Publishing.

Block A license area or contract area; each individual parcel of acreage held by an international oil company or a government.

Bonuses A payment received by the government for the right to conduct petroleum operations including: signature bonus; discovery bonus; commerciality bonus; production bonus; cumulative production bonus.

Commercial discovery Any discovery that would be economically feasible to develop under a given fiscal system.

Concession An agreement between a government and a company that grants the company the right to explore for, develop, produce, transport, and market hydrocarbons within a fixed area for a specific amount of time.

Contractor An international oil company operating in a country, on behalf of the host government, under a production sharing agreement or a risk service agreement, for which it receives either a share of production or a fee.

Cost oil An international oil company operating in a country, on behalf of the host government, under a production sharing agreement or a risk service agreement, for which it receives either a share of production or a fee.

Country risk The risk and uncertainties of doing business in a foreign country, including political and commercial risks.

Depletion The risk and uncertainties of doing business in a foreign country, including political and commercial risks.

Economic profit Gross project revenues minus total costs, which include exploration, development, and operating costs.

Economic rent The difference between the value of production and the cost to extract it. The extraction costs consist of normal exploration, development, and operating costs as well as a share of profits for the industry.

Expected value A weighted average financial value of various possible outcomes, such as either a discovery of a dry hole, weighted according to the estimated likelihood (estimated probability or success of failure) that either outcome might occur.

Gross benefits The benefits to a country that come with having foreign companies operate in a country, such as government take (share of profits), employment gains etc.

License An arrangement between an international oil company and a host government regarding a specific geographical area (block) and petroleum operations. In more precise usage, the term applies to the development phase of a contract after a commercial discovery has been made.

Operator The company directly responsible for day-to-day operations, for maintaining a lease or license, and for ensuring the rights and obligations of the other members of the contractor group are met.

Product sharing agreement (PSA) A contractual agreement between a contractor and a host government. Here the contractor bears all exploration costs and risks, as well as development and production costs, in return for a stipulated share of the production resulting from this effort.

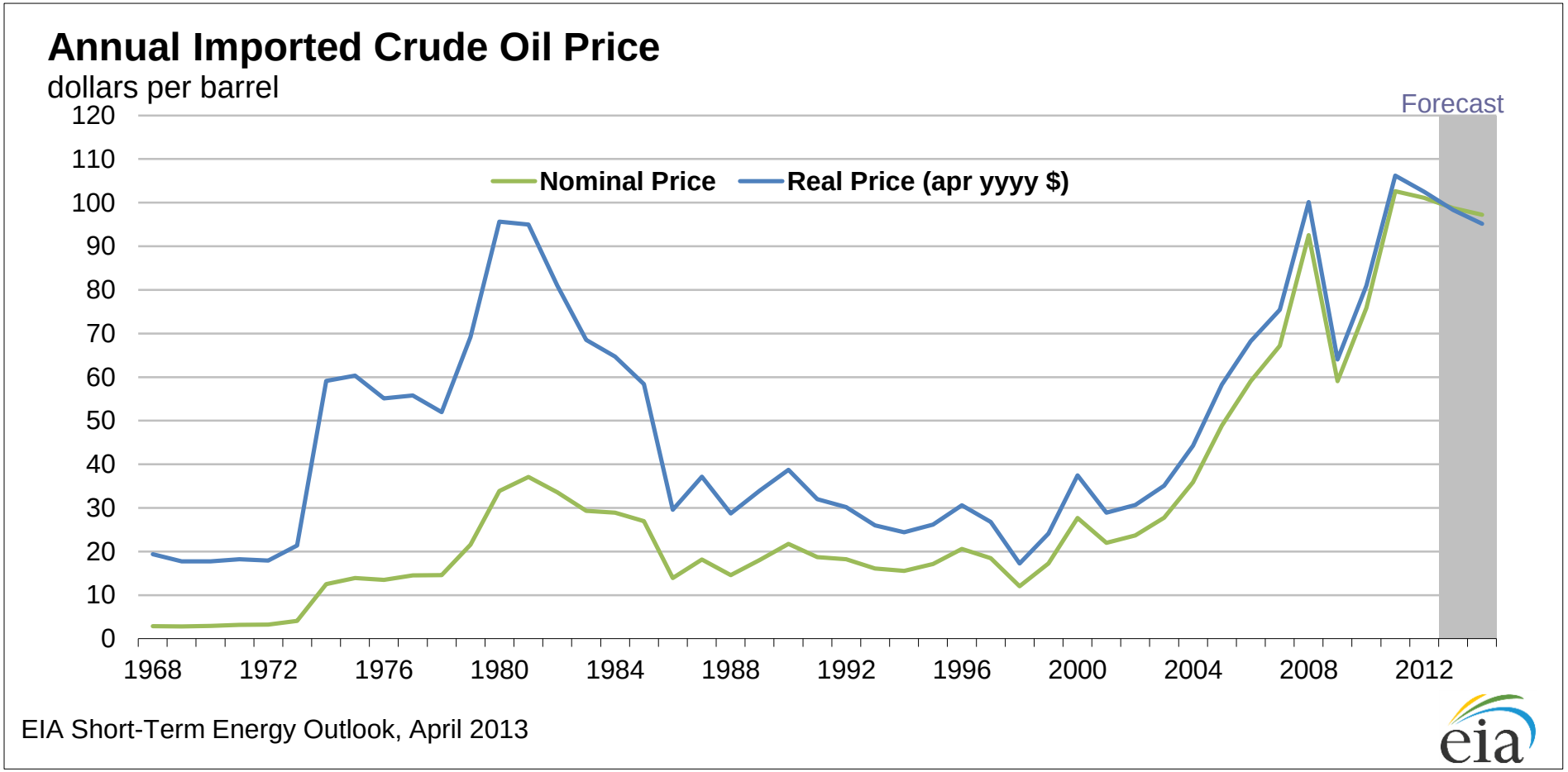
Profit oil Used in production sharing agreements; the share of production remaining after cost oil and royalties have been allocated to the appropriate parties of the contracts.

Recoverable The hydrocarbon volumes expected to be produced economically and not left behind in the reservoir.

Risk service contract A contractual agreement in which a contractor is paid a cash fee in return for performing the service of producing petroleum resources. All production belongs to the state. The contractor is usually responsible for providing all capital associated with exploration and development. In return, if exploration efforts are successful, the contractor recovers the costs through the sale of oil or gas plus a fee.

Wellhead The last valve off of a production platform from which oil is extracted; the point of valuation.

APPENDIX 2



Annual imported crude oil prices to the U.S., 1968-2012, including forecast (EIA, 2013d).

APPENDIX 3

Case study database of documents and archival records.

What	Descriptions and Use
	Petroleum Industry in Other Countries
Book: H. Ryggvik: ***Til Siste Dråpe. Om Oljens Politiske Økonomi***	Analysis of the development of the Norwegian petroleum sector. Used as background and context material, and in the analysis of host states' bargaining power, petroleum policy, and domestic capability building in the Norwegian petroleum industry.
Book-section: O.E. Engen: ***The Development of the Norwegian Petroleum Innovation System***	Analysis of the development of the Petroleum Innovation System in Norway. Used as comparative material in the analysis of the petroleum system of innovation and policies of other oil rich host states.
Analysis: EIA: ***Norway***	Analysis on Norway's petroleum sector. Used in context and as comparative material in analysis.
Statistics: EIA: ***International Energy Statistics***	Data on petroleum reserves etc. in various countries. Used in analysis on basic entry factors.
Article: A. Mohamed et al.: ***Modeling the Technology Transfer Process in the Petroleum Industry: Evidence from Libya***	Analysis of inward technology transfer in Libya's petroleum industry. Used as comparative example in the analysis.
Report: H.K. Nordås et al: ***The Upstream Petroleum Industry and Local Industrial Development: A Comparative Study***	Analysis of the upstream petroleum industry of 6 different countries. Used as comparative examples in the analysis.
Article: B. Sæther et al: ***Innovation by Co-Evolution in Natural Resource Industries: The Norwegian Experience***	Analysis of the evolution of Norway's innovation systems in resource sectors. Used as comparative material.
Article: A. Warhurst: ***Technology Transfer and the Development of China's Offshore Oil Industry***	Analysis of the role of inward technology transfer in China's offshore oil industry. Used as comparative example in the analysis.
Journal Article: R. de Oliveira: ***Business Success, Angola-Style: Postcolonial Politics and the Rise and Rise of Sonangol***	Analysis of the development of Angola's petroleum sector. Used in context and as comparative material in analysis.
Analysis: EIA: ***Angola***	Analysis of Angola's petroleum sector. Used in context and as comparative material in analysis.
Analysis: IEA: ***Angola***	Analysis of Angola's petroleum sector. Used in context and as comparative material in analysis.
	Cuba's Petroleum Sector
Article: G. Perez: ***Cuba Deepwater Exploration Opportunities Described in Southeastern Gulf of Mexico***	Analysis of Cuba's hydrocarbon potential. Used in the analysis of Cuba's entry factors in bargaining.
Article: N. Nerurkar, M. Sullivan: ***Cuba's Offshore Oil Development: Background and U.S. Policy Considerations***	Analysis of the development and status of Cuba's petroleum industry. Used in the analysis of Cuba's domestic capabilities in petroleum value chain.
Book Section: J. Piñón, J. Benjamin-Alvarado: ***Extracting Cuba's Oil and Gas***	Analysis of Cuba's petroleum industry. Used in the analysis of Cuba's basic entry factors in bargaining, capabilities along the value chain, petroleum policies towards foreign oil companies.
Book Section: J. Benjamin-Alvarado: ***Evaluating the Prospects for U.S-Cuban Cooperation on Energy Policy***	Analysis of the prospects of future U.S.-Cuban cooperation in the energy sector. Used in the analysis of Cuban petroleum policy, and Cuba's domestic capabilities.
Article: U.S. Geological Survey: ***Executive Summary – Assessment of Undiscovered Oil and Gas Resources of the Jurassic-Cretaceous Composite Total Petroleum System in the North Cuba Basin, Cuba, 2004***	Analysis of the offshore hydrocarbon potential of Cuba. Used in the analysis of Cuba's basic entry factors in bargaining.
Article: G. Perez: ***Cuba Deepwater Exploration Opportunities Described in Southeastern Gulf of Mexico***	Analysis of the prospects for offshore oil exploration in Cuba's EEZ. Used in the analysis of Cuba's basic entry factors in bargaining, and Cuba's contractual framework for offshore E&P.
Newspaper Article: P. Orsi: Repsol: ***Exploratory Oil Well off Cuba Comes up Dry***	Report of the results of Repsol's offshore exploration well. Used in the analysis of Cuba's basic entry factors in bargaining.
Newspaper Article: P. Orsi: ***2nd Offshore Oil Well also a Bust***	Report of the results of Petronas' offshore exploration well. Used in the analysis of Cuba's basic entry factors in bargaining.
Newspaper Article: P. Orsi: ***Cuba: 3rd Exploratory Offshore Well also a Bust***	Report of the results of PDVSA's offshore exploration well. Used in the analysis of Cuba's basic entry factors in bargaining.
Newspaper Article: J. Franks: ***Repsol's likely departure a Blow to Cuba's Oil Hopes***	Report stating that Repsol leaves Cuban waters. Used in the analysis of Cuba's basic entry factors.
Newspaper Article: J. Franks: ***Cuba Says Latest Offshore Well is Not Successful***	Report stating that the Repsol well was commercially unviable. Used in analysis of Cuba's entry factors.
Newspaper Article: J. Franks: ***Amid Uncertainties, Cuba Seeks Funding for Refinery Expansion***	Report on prospected refinery expansion at Cienfuegos. Used in analysis on Cuba's petroleum sector value chain.
Newspaper Article: M. Frank: ***Petrobras has Relinquished Cuba Oil Block***	Report stating the reason for Petrobras' withdrawal from Cuba. Used in analysis of bargaining power.

Newspaper Article: BBC News: Spanish Oil Company Repsol to stop Drilling in Cuba	Report stating that Repsol is to leave Cuba. Used in analysis of bargaining power.
Newspaper Article: G. Allen: ***U.S. Watches Closely as Oil Drilling Begins off Cuba***	Report on the environmental considerations of an offshore oil spill. Used as source of foreign investments made by oil companies in Cuba's petroleum industry.
Newspaper Article: Cuba Standard: ***Cuba Announces Start of More Offshore Drilling***	Report on the exploratory activities of Zarubezhneft off Cuba. Used in the analysis of Cuba's basic entry factors in bargaining.
Newspaper Article: T. Thompson: ***Cuba to Visit for Oil Drilling Talks***	Report on environmental meetings between Cuba and Bahamas in relation with Zarubezhneft drilling. Used in the analysis of Cuba's petroleum policies.
Newspaper Article: J. Varona: ***Cuba y Rusia en la senda de la cooperation***	Report on the cooperation between Cuba and Russia in the petroleum industry. Used in analysis of Cuba's petroleum policies.
Newspaper Article: Prensa Latina: ***Oil Drilling to Continue in Cuban Waters***	Report stating that PDVSA is to continue exploring in Cuban waters after the unsuccessful drilling. Used in the analysis of Cuba's basic entry factors in bargaining.
Newspaper Article: S. Wayow: ***Cuba Welcomes Help in Oil and Gas Industries***	Report stating that Cuba welcomes U.S. participation in petroleum industry. Used in analysis of Cuba's petroleum policy.
Statistical data: EIA: ***Cuba***	Statistics of petroleum production, consumption, import/export balance, refinery capacity, and proved reserves in Cuba. Used in analysis of Cuba's basic entry factors in bargains, and in assessing the results of Cuba's petroleum policies.
Statistical data: ONE: ***Anuario Estadístico de Cuba: Minería y Energia***	Statistics of petroleum production, imports, consumption. Used in analysis of Cuba's basic entry factors in bargains, results of Cuba's petroleum policies, Cuba's dependence of fossil fuels for electricity generation.
Web Pages: ONRM: ***Fundación ; Antecedentes***	Foundation and development of state-owned institutes in Cuba's petroleum sector. Used in analysis of Cuba's petroleum policies and value chain.
Web Page: Geociencias: ***Geociencias***	Information about bi-annual petroleum congress held in Havana. Used in analysis of petroleum policy.
Article: J.A.B. Belt: ***The Electric Power Sector in Cuba: Ways to Increase Efficiency and Sustainability***	Analysis of Cuba's electric power sector. Used in the analysis as indicator of Cuba's dependence of fossil fuels for electricity generation.
Transcript: The Brookings Institution: ***Cuba's Energy Future: Strategic Approaches to Cooperation***	Discussion of Cuba's energy future among U.S. energy experts. Used in analysis of Cuba's petroleum policy, and domestic capabilities.
Newspaper Article: Cuba Standard: ***Government Strips Cupet of Foreign Trade Privileges***	Report of Cuba's reordering of foreign trade activities. Used in analysis of Cuba's petroleum policy.
Newspaper Article: Cuban News Agency: ***Cuba Sets up Ministry of Energy and Mines***	Report of the restructuring of MINBAS. Used in analysis of Cuba's petroleum policy.
Article: M. Cereijo: ***Republic of Cuba: Power Sector Infrastructure Assessment*** **á é ó**	Analysis of Cuba's power sector. Used in analysis on Cuba's domestic capabilities along petroleum industry value chain, and dependence on fossil fuels for electricity generation.
Portfolio: Ministerio del Comercio Exterior y la Inversión Extranjera: ***Cuba Portfolio Projects 2012***	Portfolio of Cuban projects open for foreign investment. Used in analysis of Cuba's petroleum policy, institutional framework.
Newspaper Article: R. Piñón: ***Piñón on Energy: Cuba Re-Organizing its Energy Sector***	Article considering the reorganization of MINBAS. Used in analysis of Cuba's petroleum policy
Report: Norad: ***Oil for Development Programme: Annual Report 2011***	Report presenting OfU's development programs in different countries. Used in analysis of Cuba's petroleum policies, domestic capabilities.
Data Base: C. Navarro: ***Mexico, Cuba Discuss Cooperation in Energy Sector***	Data base news of cooperation talks between Pemex and Cupet. Used in analysis of Cuba's petroleum policy.
Report: C. Romero: ***South-South Cooperation between Venezuela and Cuba***	Analysis of the economic, commercial, and social cooperation between Cuba and Venezuela. Used in analysis of Cuba's petroleum policies.
Article: J.A. Suárez et al.: ***Energy, Environment, and Development in Cuba***	Analysis of energy, environment, and socio-economic development in Cuba since 1959. Used in analysis of petroleum policies.
Booklet: Cupet: ***Petroleum in Cuba***	Booklet aimed at presenting investment opportunities in Cuba's petroleum industry. Used in analysis of Cuba's petroleum policy, value chain.
Work Shop booklet: Petrad: ***Workshop on Land Facilities and Impact Assessments for the Offshore Upstream Petroleum Sector***	Booklet of Petrad work shop in Cuba, June 2012. Used in analysis of Cuba's petroleum policy.
Work Shop booklet: Petrad: ***Workshop on Contingency Planning and Emergency Response***	Booklet of Petrad work shop in Cuba, October 2012. Used in analysis of Cuba's petroleum policy.
Newspaper Article: Granma: ***Ministerio de Energia y Minas: A Tono Con Los Nuevos Tiempos***	Article stating the new ministry structure in basic industries in Cuba. Used in analysis of Cuba's petroleum policy and system.
Newspaper Article: Havana Journal: ***President Raul Castro Has Met with Ten Presidents Since October 2008 (Now 12)***	Raúl's trips abroad. Used in analysis of Cuba's petroleum policy.
Newspaper Article: Reuters: ***Cuba Oil Production to Increase with More Chinese Equipment Arriving***	Inward transfer of drilling rigs and service equipment. Used in analysis of Cuba's petroleum policy

Journal Article: Oil & Gas Jounrnal: ***Drilling Market Focus: Chinese Build Rigs, Drillers Venture Abroad***	
Newspaper Article: Reuters: ***Cuban Off-Shore Oil Drilling Put off until 2009***	Report of Repsol's first well drilled in 2004. Used in analysis of bargaining power.
Web Page: MINCEX: ***Introducción – Inversión Extranjera***	On Cuba's official policy towards foreign investment. Used in analysis of Cuba's petroleum policy.
Newspaper Article: M. Voss: ***Cuban Oil Projects Fuels US Anxieties***	U.S. reaction of possible offshore oil in Cuba. Used as source of reserves estimate.
Newspaper Article: Havana Journal: ***Cuban Government Prematurely Terminates Pebercan Oil Production Contract***	The Pebercan incident. Used in analysis of Cuba's bargaining power and petroleum policy.
Journal Article: A. Navarro: ***Energy Security: Analyzing US, Mexican and Cuban Actors in the Deepwater Gulf***	Analysis of different oil policies between states. Used in analysis of Cuba's petroleum policy.
	Cuba: Innovation and Economy
Article: J. Jover et al.: ***Cuba: University, Innovation, and Society: Higher Education in the National System of Innovation***	Analysis of the role of Cuba's universities in Cuba's NIS. Used as indicator of Cuba's general human capital, and innovation policy.
Book Section: J. Domínguez: ***On the Brink of Change: Cuba's Economy and Society at the Start of the 2010s***	Analysis of Cuba's economic transition. Used in analysis as indicator of Cuba's economic and human capital resources.
Book Section: O. Villanueva.: ***Foreign Direct Investment in China, Vietnam, and Cuba: Pertinent Experiences for Cuba***	Analysis of the role of FDI in Cuba. Used in analysis as source on the role of FDI in Cuba's petroleum industry.
Book Section: C. Brundenius, B. Göransson: ***Universities in Transition: The Changing Role and Challenges for Academic Institutions***	Analysis of the role of academic organizations within the contexts of innovation and economic growth and development in 12 countries, including Cuba. Used as indicator of Cuba's human capital and education policy.
Article: R. Feinberg: ***The New Cuban Economy: What Roles for Foreign Investment?***	Analysis of Cuba's inward foreign investment policies. Used in analysis as contextual evidence of Cuba's petroleum policies.
Report: UNESCO: ***National Science, Technology and Innovation Systems in Latin America and the Caribbean***	Report of the formal NIS structure and functions in different Latin American and Caribbean countries. Used in analysis of Cuba's petroleum policies.
Article: T. Sáenz: ***The Path to Innovation: The Cuban Experience***	Analysis of Cuba's S&T policies since 1959. Used in analysis of Cuba's petroleum policies, sectoral system of innovation.
Report: ITOPF: ***Cuba***	Description of the oil spill security response system of Cuba. Used in analysis of Cuba's petroleum policy and petroleum industry value chain.
Report: D. Villavicencio, L. Ponce: ***The Republic of Cuba***	Report on the structure of Cuba's formal innovation system. Used in analysis of Cuba's innovation policy and system in relation to petroleum industry.
Report: EIU: ***Cuba Risk Assessment*** **Report: Coface:** ***Cuba***	Reports on investment risks in Cuba. Used in analysis of Cuba's bargaining power.
Journal Article: Oil & Gas Journal: ***Cuba's Oil, Gas Production Rising, Politburo Member Says***	Article on rising production levels in Cuba. Used in analysis of Cuba's petroleum policy.
Newspaper Article: P. Grogg: ***CUBA: Petrochemical Complex Poses Major Environmental Challenge***	Newspaper article on prospected petrochemical facilities at Cienfuegos. Used in analysis on petroleum sector value chain.
Newspaper Article: B. Gorman: ***Spain Drills for Crude Oil in Cuba – Halliburton wants Embargo Lifted***	Newspaper article stating the interest of U.S. companies to invest in Cuba's petroleum sector. Used in analysis on relative bargaining power.
Report: S. Castellón: ***Evolución y Perspectivas de la Producción de Petróleo en Cuba***	Report on the development of Cuba's petroleum sector until 2003. Used in analysis on petroleum policy and value chain.
	Foreign Oil Companies
Report: Sherritt International Cooperation: ***Annual Report 2011***	Report of Sherritt's financial statement and activities. Used in the analysis of Sherritt's activities in Cuba's petroleum industry value chain, production numbers, and in extension Cupet's production numbers
Report: Sherritt International Cooperation: ***Sherritt Reports Fourth-Quarter and Year-Ended December 31, 2012 Results***	Same as the above.
Report: Sherritt International Cooperation: ***2011 Annual Information Form***	Same as the above.
Report: Zarubezhneft: ***Joint Stock Company "Zarubezhneft" 2011***	Report of Zarubezhneft's financial statement and activities. Used in the analysis of Cuba's petroleum policy, bargaining power, and Zarubezhneft's role in the petroleum industry value chain.

APPENDIX 4

INTERVIEW GUIDE

This interview is part of the data collection process for my master thesis. I am a student at the Centre for Technology, Innovation and Culture at the University of Oslo (UiO), Norway. I am also an intern at the Norwegian Institute of International Affairs (NUPI) where I am writing my thesis. NUPI is currently cooperating with *Centro de Estudios de la Economia Cubana* (CEEC) on different and relevant economic topics. My thesis centers on domestic capability building in the petroleum sector and seeks to explore how Cuba encounters different challenges connected to such processes.

As you might be aware of, Norway managed to develop technologies capable of exploiting offshore oil and gas deposits in a cost-effective way, while simultaneously enabling Norwegian firms to enter and become globally competitive production and supplier firms. The building of domestic capabilities was enabled by the development of a system of organizations and institutions designed to support innovation, learning, and transfers of knowledge and technology within and towards the industry. Through this interview I will seek to develop an understanding of Cuban policies towards domestic capability building in the petroleum sector, as well as how such capabilities are sought developed.

Please note that the transcription of this interview will be used for analytical purposes only. The transcription will not be disclosed to any persons other than me, with the exemption of my supervisors in Norway or other persons close to the project, if I was to need specific assistance in the analysis. I would also like to be able to cite phrases from the interview in my thesis, with full name and working title if possible. If desired, I will send the citations by e-mail for approval. Like most theses conducted at the UiO, the thesis will be available online at www.duo.uio.no, the digital archive of UiO after completion.

GENERAL THEMES TO BE COVERED

I: Structure and Capabilities in Cuba's petroleum sector today

1. How would you characterize the **structure** of the Cuban petroleum sector today?
    a. Degree of centralization in decision-making? (Government -> MINBAS -> ONRM -> Cupet/Foreign Companies)
2. In general, how would you characterize the Cuban petroleum industry **capabilities** as it is today?
    a. In terms of Exploration & Production (upstream) activities? Onshore and coastal? Offshore?
    b. Transportation & Storage?
    c. Oil refining & Gas processing?
    d. Marketing & Distribution of oil and gas products?
    e. Petrochemical industry?
    f. Environmental considerations?
    g. What about the existence of a **supply sector** (oilfield services, equipment)?
3. What has been the role of **foreign oil companies** such as Sherritt in terms of access to capital, industrial know-how, and technology?
    a. Have Cuban actors been able to **assimilate** (and transform) these technologies in their own operations?
4. In your opinion, what are the **main challenges** that Cuba faces today for further developing its petroleum industry capabilities – especially offshore?
    a. Access to technology/know-how from abroad? **U.S Embargo**
    b. Lack of domestic skills, capital/funding or technologies?
    c. Lack of incentives or regulatory framework that inhibits the creation of non-state firms, e.g. in oilfield services & equipment?
    d. Low degree of **bargaining power** versus foreign oil companies?

II: Strategies to develop petroleum industry capabilities?

1. Do you know if Cuba puts up **local content demands** of some sort in their bargaining (for concessions) with foreign oil companies? (Technology/Knowledge transfer, use of local workforce, training, etc.) (that is, not only rents (taxes, royalties) in PSAs)
    a. If yes: Have these demands been successful? Examples?

   b. If no: why not? (lack of interest? lack of bargaining power?)
2. How important has the cooperation with **PDVSA** been for Cupet and Cuba's petroleum industry?
   a. For access to knowledge, technology, capital?
3. Where in the **petroleum value chain** would you say Cuba is putting most emphasis in increasing its capabilities and skills?
   a. To what goal? (increased revenues, or also access to technologies and skills that might be used in other industries (backward and forward linkages?)
4. To what degree would you say Cuba is pursuing capabilities to conduct upstream **offshore** activities?

III Domestic system to support the development of increased petroleum sector capabilities

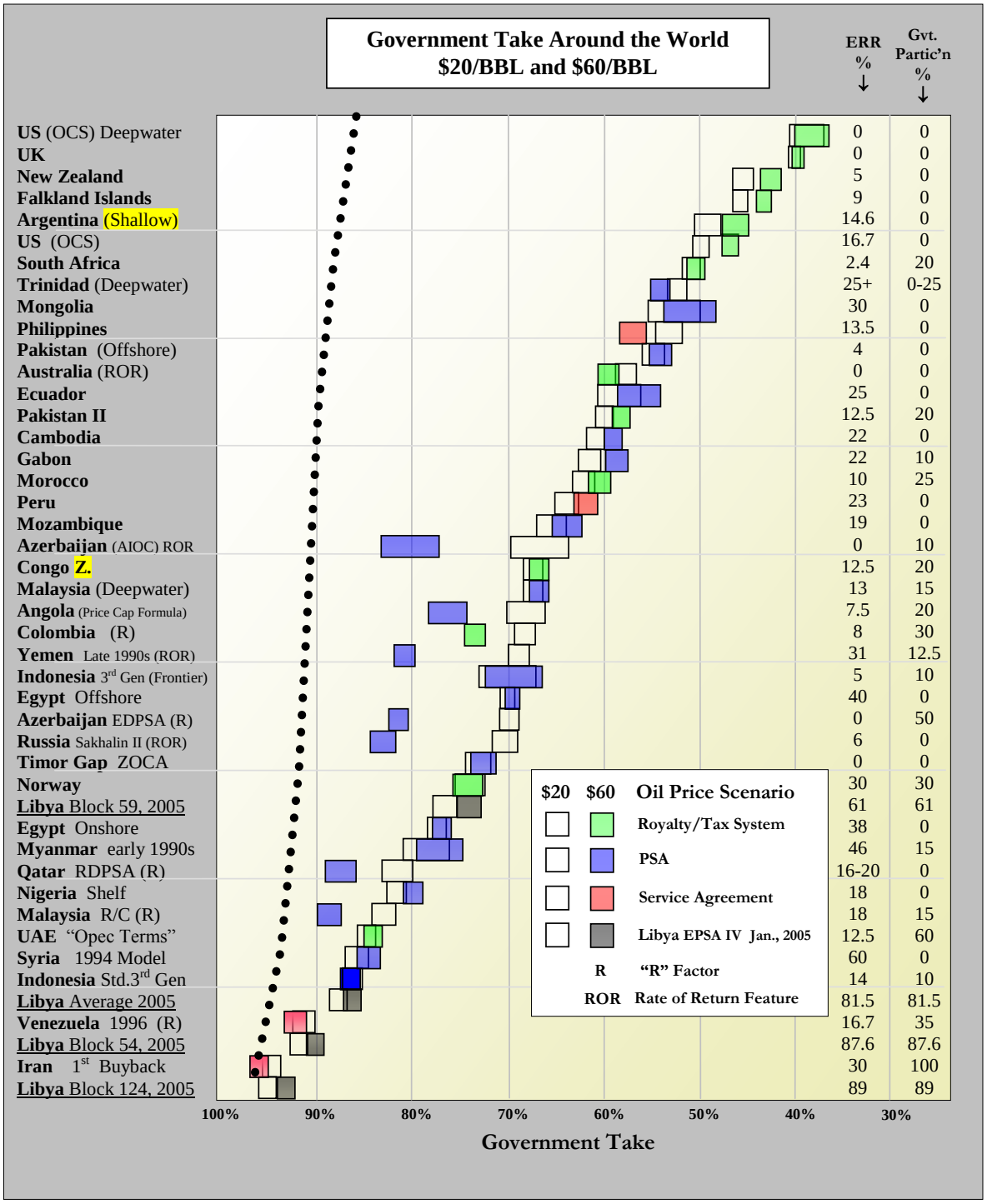
1. Would you say the petroleum sector – to increase domestic production etc. – is highly prioritized by Cuban authorities today?
2. Through its **educational system**, is Cuba able to supply its petroleum industry with a skilled workforce (engineers, managers, geologists etc.)?
3. How about petroleum **research** activities (CEINPET) or petroleum organizations (institutes)?
   a. How has this research helped actors in Cuba's petroleum industry (seismic studies etc., lubricants)?
   b. Are there any research facilities or petroleum research institutes besides CEINPET ?
4. How would you say Cuban **laws** (and routines) governing petroleum industry activities provide (potential) petroleum actors with incentives to invest in this sector?

IV The prospects of offshore oil today

1. After three dry offshore wells during 2012, how would you consider the **prospects** of offshore petroleum production in Cuba in the near-future (Zarubezhneft)?

APPENDIX 5

GOVERNMENT TAKE OF PETROLEUM PROJECTS AROUND THE WORLD



Government take of petroleum projects around the world at US$20 per barrel and US$60 per barrel (Johnston, 2007, p. 74).